Office of the
Deputy Prime Minister
Creating sustainable communities

Affordability Targets: Implications for Housing Supply

Technical Appendix

August 2005

Philip Allmendinger: The University of Reading
Mark Andrew: The University of Reading
Michael Ball: The University of Reading
Gavin Cameron: University of Oxford
Alan Evans: The University of Reading
Kenneth Gibb: University of Glasgow
Jennifer Goody: Peter Brown Partnership
Alan Holmans: University of Cambridge
Diana Kasparova: Policy Studies Institute
Geoffrey Meen: The University of Reading
Sarah Monk: University of Cambridge
John Muellbauer: University of Oxford
Anthony Murphy: University College Dublin
Christine Whitehead: London School of Economics
Alan Wilson: Oxford Economic Forecasting

The Office of the Deputy Prime Minister
Eland House
Bressenden Place
London SW1E 5DU
Telephone 020 7944 4400
Web site www.odpm.gov.uk

Further copies of this publication are available from:
ODPM Publications
PO Box 236
Wetherby
West Yorkshire
LS23 7NB
Tel: 0870 1226 236
Fax: 0870 1226 237
Textphone: 0870 120 7405
E mail: odpm@twoten.press.net
or online via the Office of the Deputy Prime Minister's web site.

Printed in Great Britain on material containing 75% post-consumer waste and 25% ECF pulp.

August 2005

Product code: 05 HC 03499 (b)

Contents

Introduction

This Technical Appendix accompanies the final report of the Affordability project. It provides details of the underlying equations in the model and basic operating instructions. The model has been coded in Excel and basic knowledge of Excel is assumed.

The model covers the nine English Government Office Regions and the models for each region are interlinked; house prices in one region, for example, are related to house prices in other regions. Each region is represented by a set of worksheets, covering the main sectors of the model. The interlinkages are shown in Figure 1, which is repeated from the Final Report. The structure is described in that Report. Therefore, *within* each region the following set of worksheets are defined:

(i) Summary (**SummaryX**)

(ii) Population (**PopnX**)

(iii) Natural population increase (**NatIncX**)

(iv) Interregional Migration (**MignX**)

(v) International migration (**IntMigX**)

(vi) Household formation (**HouseX**)

(vii) Housing market (**PricesX**)

(viii) Labour market (**LabourX**)

"**X**" in brackets above refers to the region and takes the mnemonics SE (South East), GL (London), E (East), SW (South West), EM (East Midlands), WM (West Midlands), YH (Yorkshire & Humberside), NW (North West), NE (North East).

In addition, the model includes a summary table for the country as a whole (**Summary**), where affordability and construction indicators for all the regions are brought together in one sheet. This sheet is of considerable importance for the operation of the model. Finally, the model also includes a sheet where variables (typically exogenous) that have no regional variation are defined (**National**). The most important are interest rates and consumer prices.

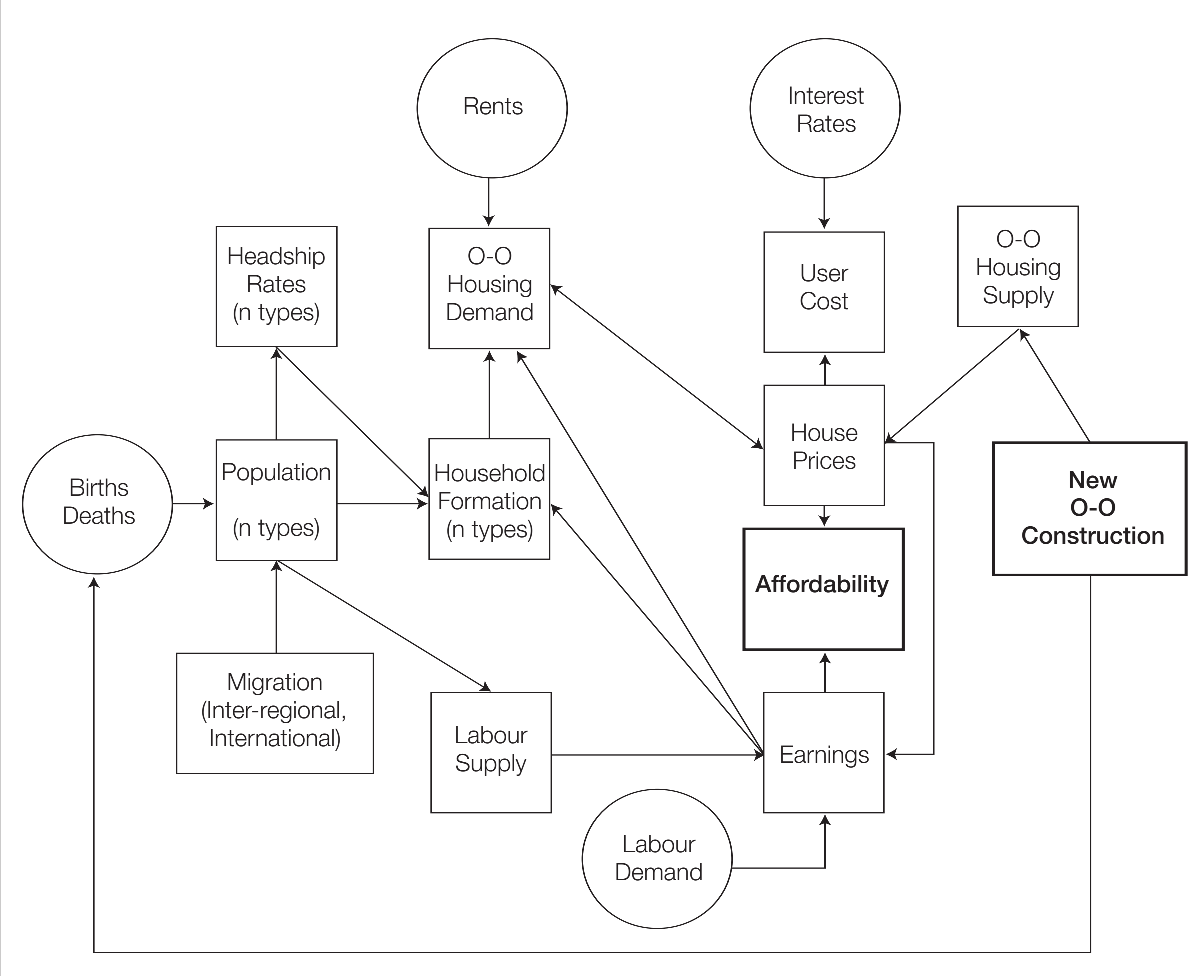
In the following sections, the structure of the worksheets is described, bringing in the estimated equations at the appropriate points. The Appendix concentrates on the South East, but the operation of the model is the same for each of the other regions. In fact, as described in the main report, there are two versions of the model:

Version (1): This includes a relatively complex set of equations for employment, earnings, migration, house prices.

Version (2): the house price, migration and unemployment equations are replaced by simpler versions.

The Final Report describes some of the differences in the simulation properties between the two equation sets. Users can move between the two versions of the model, using a Zero/One switch, located in the overall summary worksheet (row 53).

Figure 1: **Model Flow Chart**

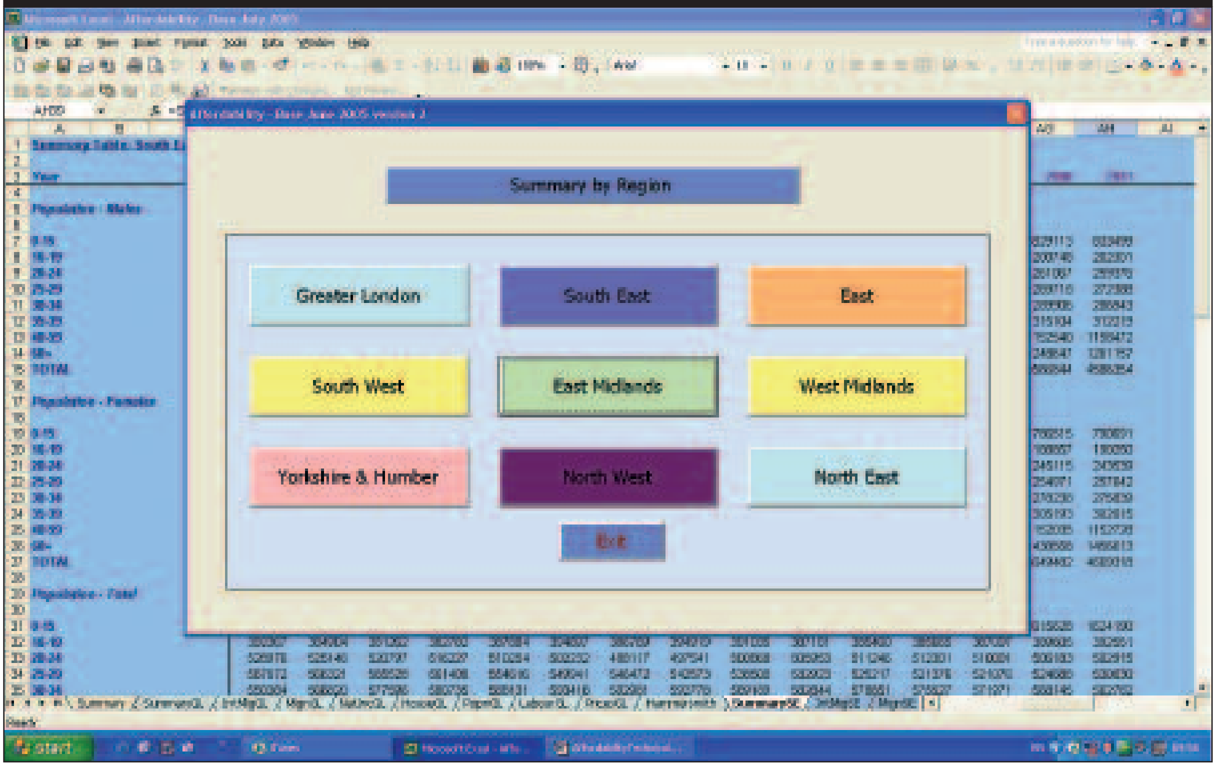


Getting Started

Over time, the model bases will change as more (historical) data becomes available and re-estimation or model extensions take place. But, as an example, we take the base constructed in July 2005 (**Affordability – Base July 2005**). As noted in the last section, the base contains two versions, which differ according to the complexity of the equation sets for house prices, migration and unemployment. However, the values for the main variables in the two bases have been approximately brought into line with each other, in order to avoid operating with two radically different base scenarios. However, switching between the versions causes some modest changes to the base scenario. **Remember the overall Summary worksheet contains the switch. Setting row 53=1 means Version 1 is used. A value of 0 implements Version 2. The *same* value for the switch must be set for all time periods i.e. the user should not switch between model versions part way through the simulation.**

Opening the model is the same as for any Excel workbook. The model will return to the last worksheet used. However, at this point, the user may find it valuable to return to the model's "front end" by pressing "**Control D**". The following screen will appear, Figure 2.

Figure 2: Front End

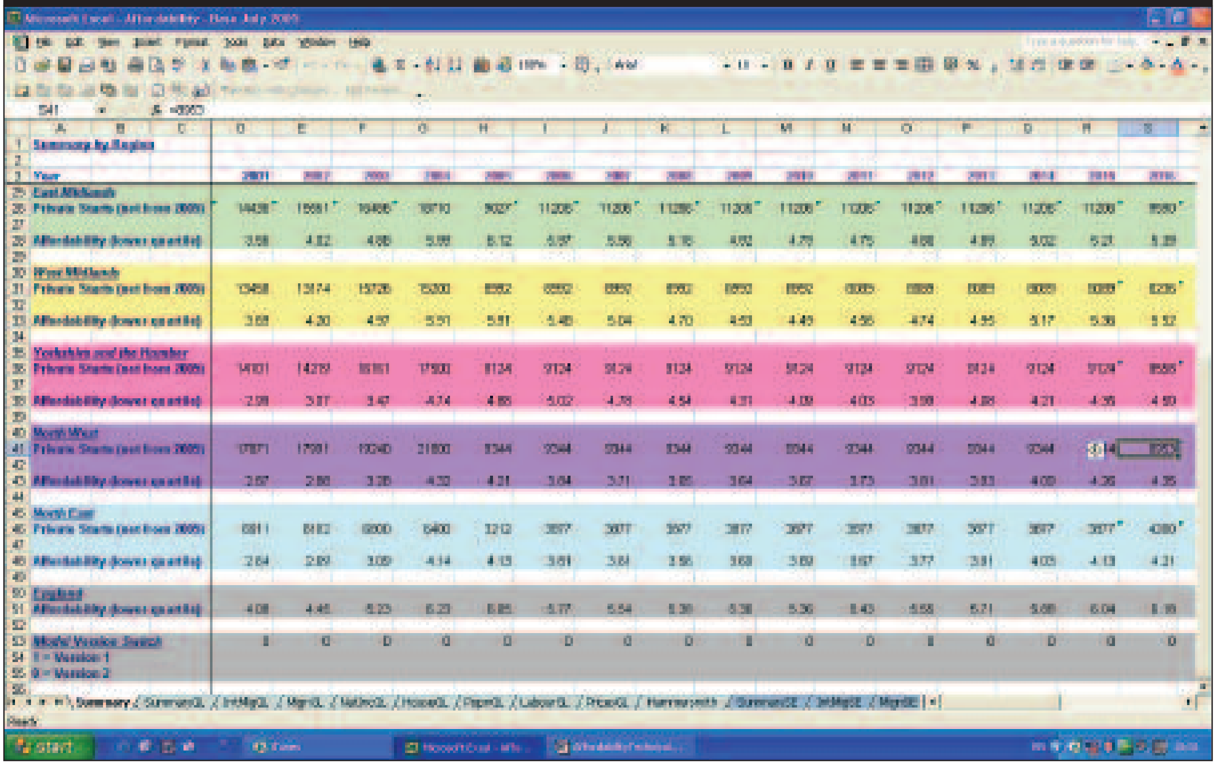


This provides a quick route for moving to the worksheets for any particular region. To do this, simply, click on the appropriate region and then "**Exit**". However, a good starting point to go to the "**Summary by Region**". This will bring up Figure 3, which is the **Summary** sheet described sheet described above (note the switch is at the bottom of Figure 3).

For each region, two variables are given – the number of housing starts and the affordability ratio (measured in terms of the lower quartile house price to income ratio). These are the boxes highlighted in Figure 1 – they tell us how a change in construction affects the central target. At the most basic level, all the user needs to do to look at the effect of changes in the level of construction on affordability is simply to overwrite the starts figures, for any or all regions in the table. The model will do the rest and the user just needs to look at the results for affordability. Indeed, the model is password protected and the only variable the user can change without knowledge of the password is the "starts" variable in this table. This is in order to prevent accidental overwriting of the model's equations. However, concentrating on this table alone has drawbacks:

- This tells the user little about the economic processes that drive the outcomes – the model would be a black box
- There are some caveats concerning the input of different levels of construction, according to the objectives of the user. These are described below.

Figure 3: **The Summary Worksheet**



Four further points should be noted concerning Figure 3.

(i) The figure shows projections to 2016 (a year which receives particular attention in the Final Report). In fact, the model solves to 2031.

(ii) The regions are consistently colour-coded throughout the model.

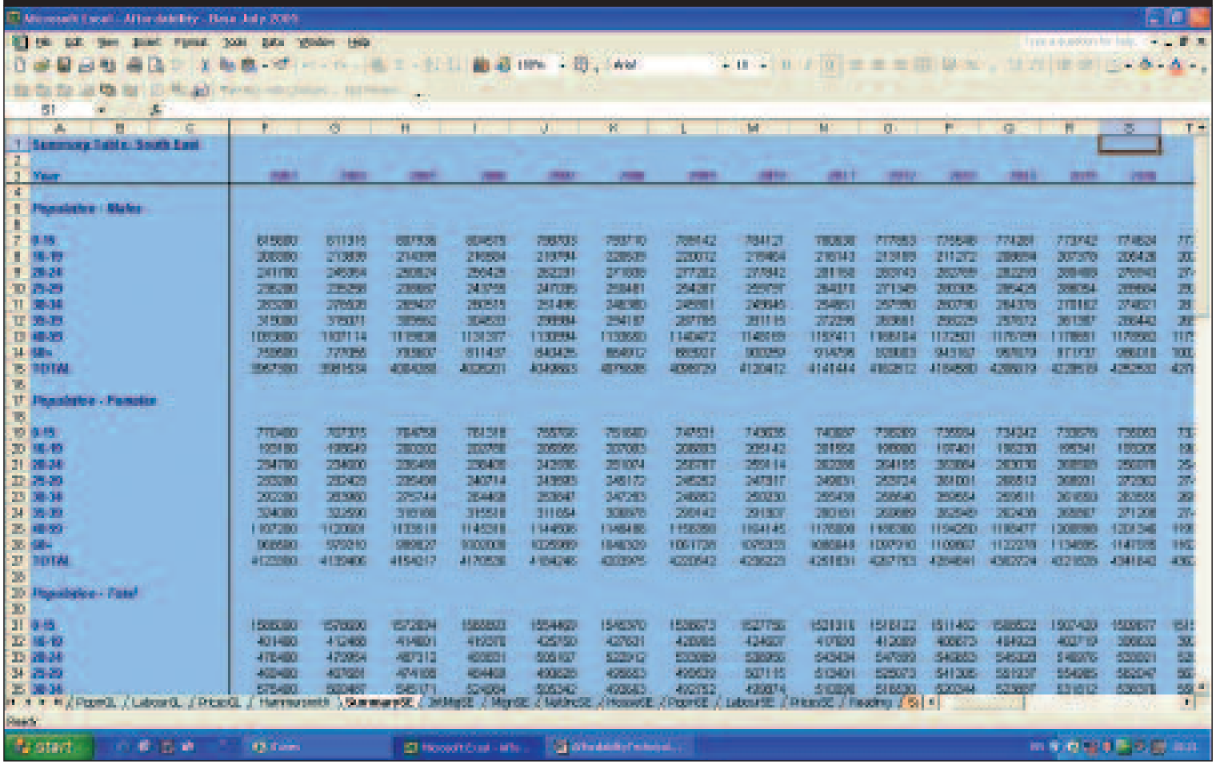
(iii) The baseline data for construction are consistent with Regional Policy Guidance (RPG). The user inputs values for housing starts, but this feeds through to completions with an assumed one year time lag. In turn, completions feed into the housing stock. These interactions take place in **PricesSE**. The historical data are expressed in terms of *gross* starts, but the projections are *net*, in line with the way in which RPG numbers are generally expressed. The main difference between net and gross values is an allowance for conversions and demolitions.

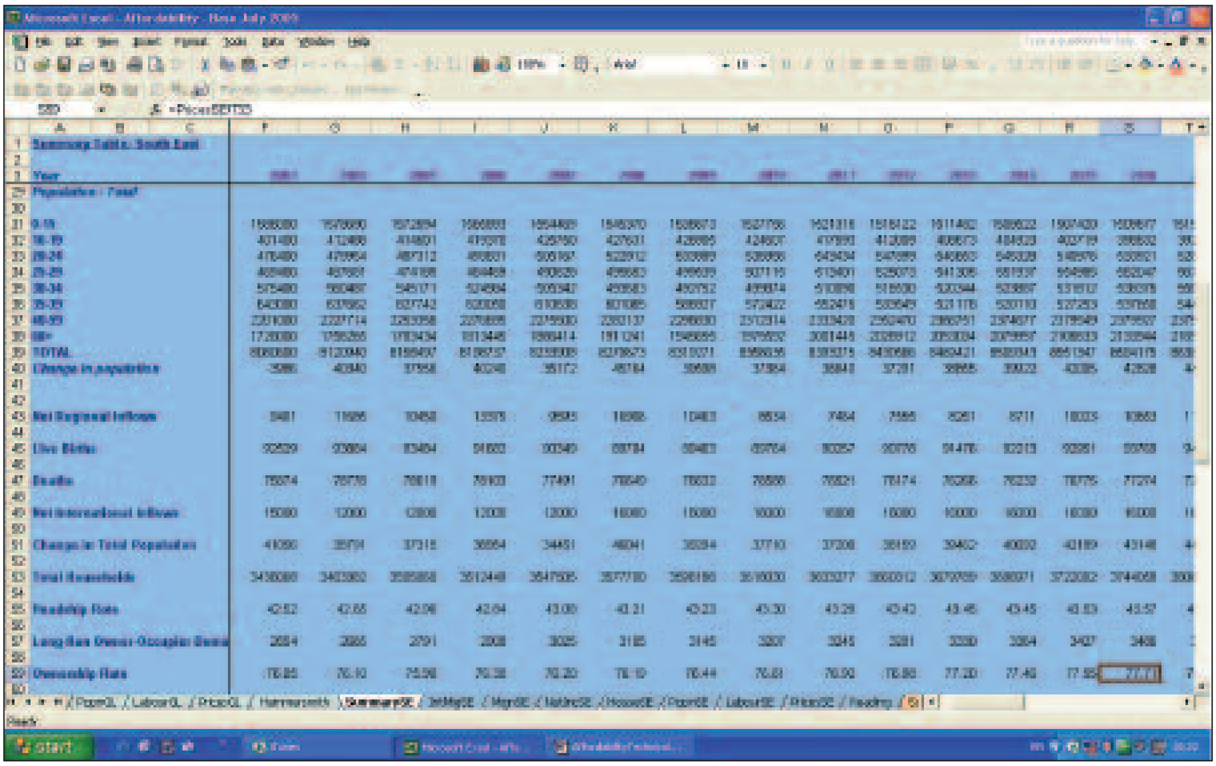
(iv) The starts figures are for *market* housing. The model automatically makes an additional allowance for *affordable* housing. The model assumes that 30% of *total* construction is affordable in all regions, except London, where the proportion is 50%. However, the user needs to beware if alternative assumptions on the affordable housing share are required. For example, the simulations in the Final Report assume that all additional housing is market housing. To take this into account requires different input values for starts and means that some variables in the tables need to be treated with care (notably the owner-occupier housing stock and the owner-occupation rate). Furthermore, sometimes, the user may want to input affordable housing shares that differ from those in the base. This is possible, but requires changes to the equations in the base. *Overall, the advice is to be careful about the nature of the simulation you are conducting. This is possibly the main area in which the user could make errors.*

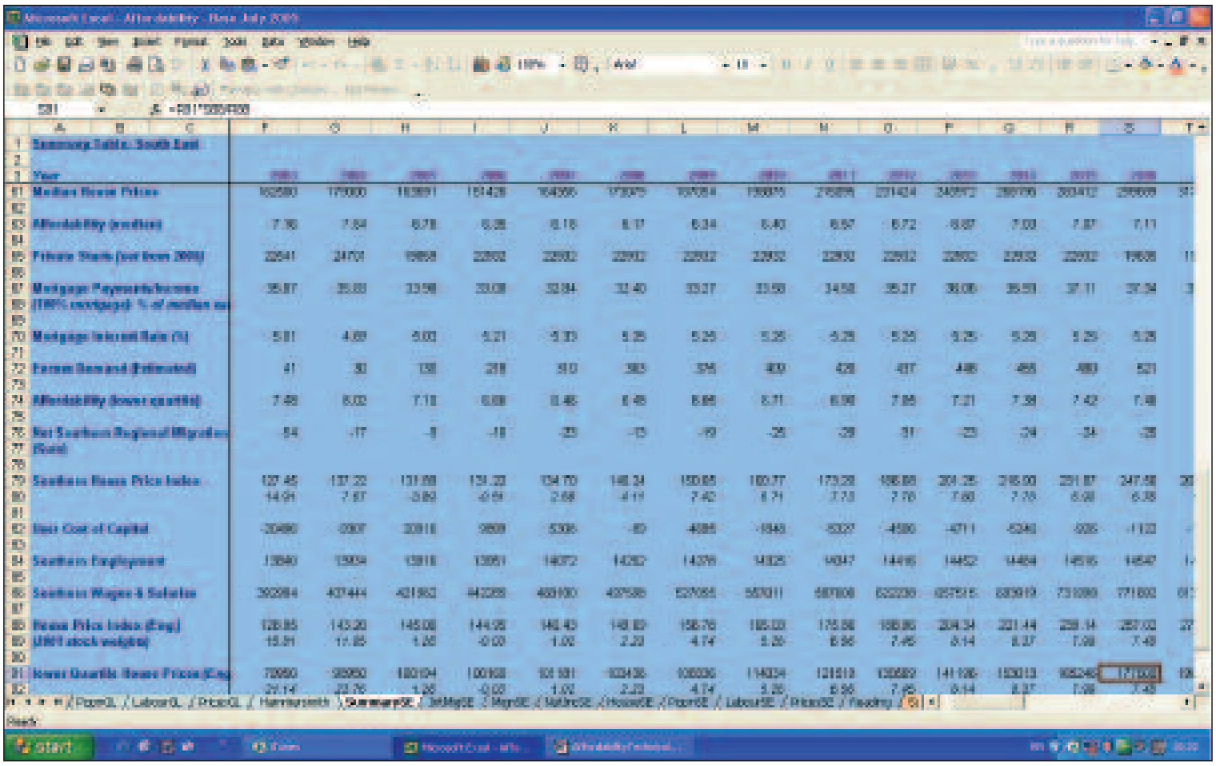
The Regional Summary Sheet

Figure 4 gives the output from the regional summary table. It brings together the key variables from the remaining worksheets. Therefore, it provides a quick way of examining the key outputs of the model. However, the user should not attempt to over-write values in this table, which gives *outputs* from the model rather than *inputs*. Typically, changing variables in this sheet will not feed back into the rest of the model.

Figure 4: **The Regional Summary (SummarySE)**







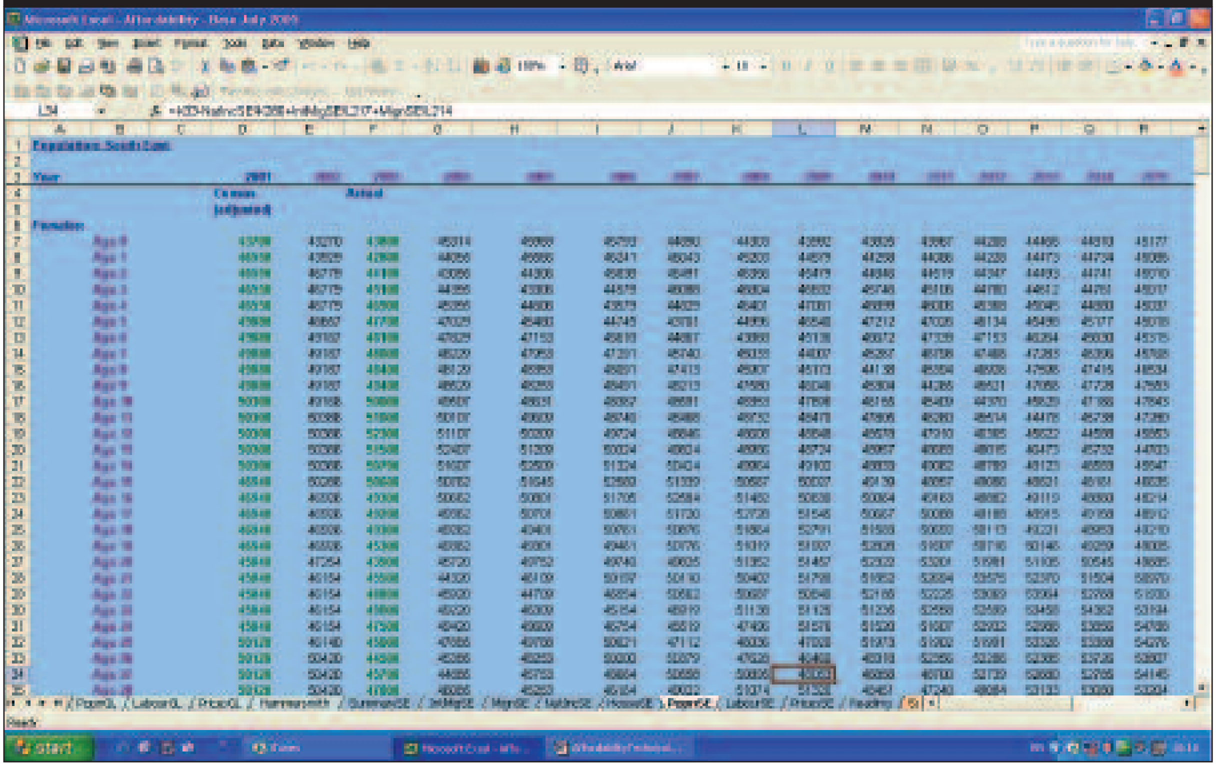
	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Summary Table: South East														
Year	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Median House Prices	162580	175000	163891	151428	164366	173975	187054	196875	215095	231424	240972	260795	263412	299009
Affordability (median)	7.36	7.64	6.78	6.26	6.18	6.17	6.24	6.40	6.57	6.72	6.87	7.03	7.07	7.11
Private Starts (set from 2005)	22641	24701	19858	22932	22932	22932	22932	22932	22932	22932	22932	22932	22932	19608
Mortgage Payments/Income (100% mortgage) % of median ...	35.87	35.83	33.58	33.08	32.84	32.40	33.27	33.58	34.58	35.27	36.06	35.93	37.11	37.04
Mortgage Interest Rate (%)	5.81	4.69	5.03	5.21	5.33	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.25
Excess Demand (Estimated)	41	30	138	218	310	383	376	409	428	437	446	455	483	521
Affordability (lower quartile)	7.48	8.02	7.18	6.88	6.46	6.45	6.65	6.71	6.98	7.05	7.21	7.38	7.42	7.48
Net Southern Regional Migration (Scot)	-54	-17	-8	-18	-23	-15	-19	-25	-28	-31	-23	-24	-24	-28
Southern House Price Index	127.45	137.22	131.88	131.23	134.70	140.24	150.65	160.77	173.28	186.68	201.25	216.00	231.87	247.58
	14.91	7.67	-3.89	-0.51	2.68	4.11	7.42	6.71	7.73	7.70	7.80	7.78	6.98	6.78
User Cost of Capital	-20480	0307	20918	9589	5306	-83	4085	-1846	-5327	-4580	-4711	-5240	-935	-1122
Southern Employment	13940	13934	13916	13951	14072	14262	14276	14325	14347	14416	14452	14484	14515	14547
Southern Wages & Salaries	392984	407444	421962	442285	463100	497585	527065	557011	587806	622236	657515	689919	731080	771692
House Price Index (Eng)	128.85	143.20	145.08	144.35	146.43	149.69	156.76	165.03	175.86	188.86	204.34	221.44	238.14	257.02
(2001 stock weights)	15.91	11.85	1.26	-0.03	1.02	2.23	4.74	5.26	6.56	7.45	8.14	8.37	7.58	7.43
lower Quartile House Prices (Eng)	79950	95950	100104	100168	101181	103436	108036	114034	121519	130589	141196	153013	165245	177508
	21.14	20.76	1.26	-0.02	1.02	2.23	4.74	5.26	6.56	7.45	8.14	8.37	7.58	7.43

The Population Table

The population table is large and only segments are shown in Figure 5. But this is sufficient to illustrate the key features. The table produces the central population identity, disaggregated by age and by other characteristics.

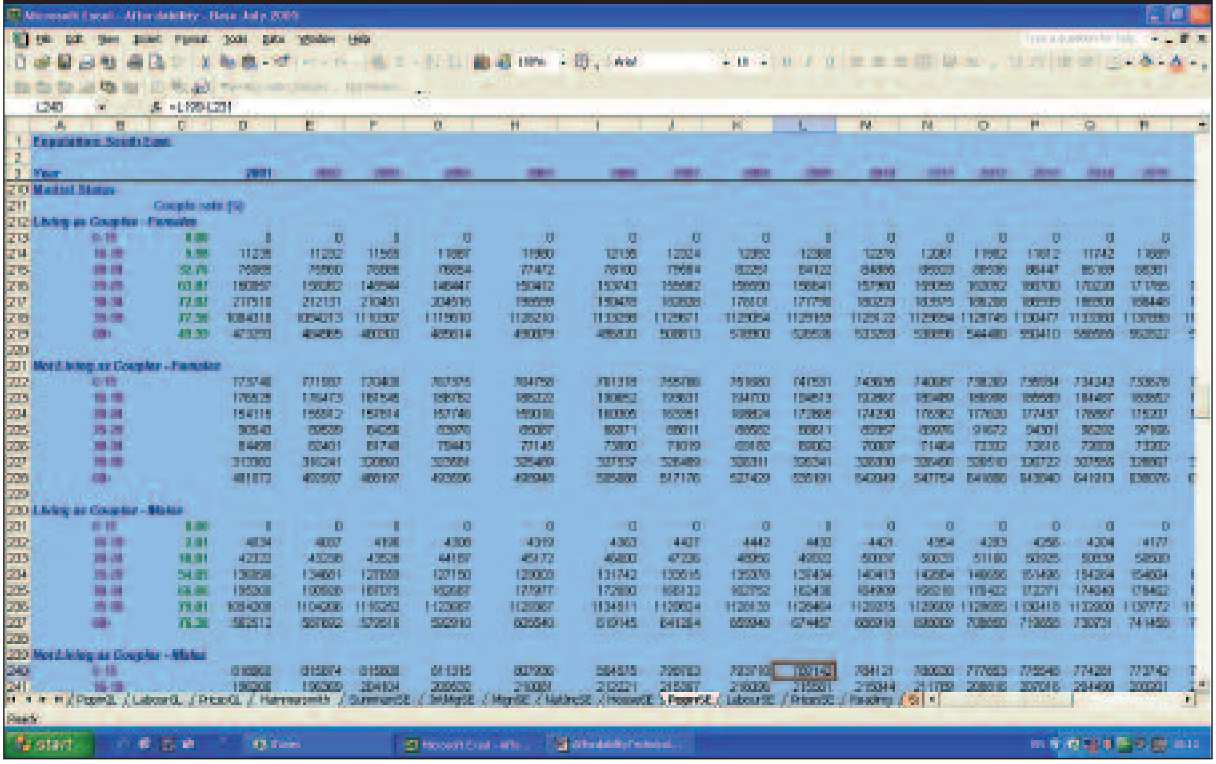
The first part of the table calculates population by gender in single year age bands (the over 85s are aggregated to one group). The starting point is the 2003 outturns, taken from the official 2003-based population projections. These are given in green along with the 2001 adjusted census numbers. Given the starting year, the population of age (z) in any year (t) is the population of age (z-1) in year (t-1) minus deaths plus interregional and international migration. Try clicking on any cell to see how this is obtained through links to other worksheets (notably the migration sheets). The only exception to the identity is for those aged 0, where, obviously, births have to be taken into account.

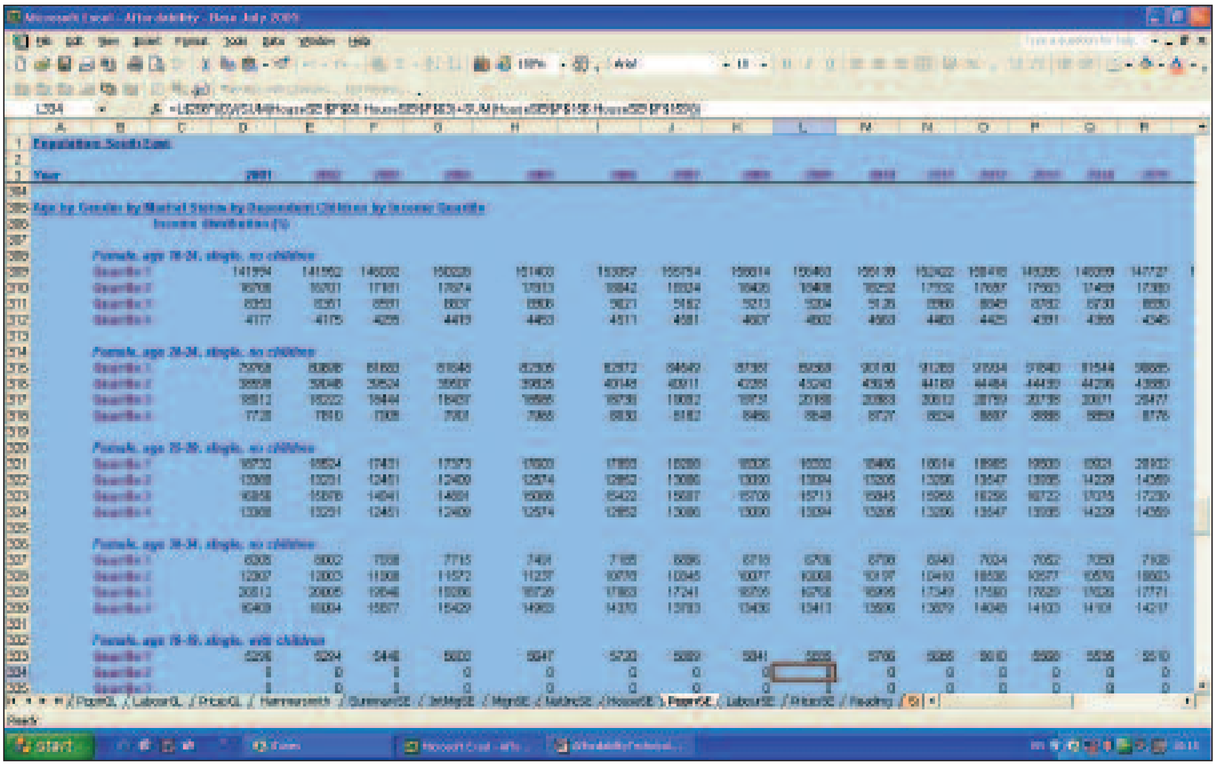
Figure 5: The Population Table (PopnSE)



For most parts of the model, population by single age is not required and so the second part of the table aggregates to age groups. The aggregation chosen is designed to fit in with the requirements of the household projections. We shall see below that headship rates are dependent on a range of different demographic and economic characteristics. Therefore the population has to be broken down into similar categories. Therefore, the model derives the number of people in each age, gender, marital status, dependent children and income group (see the last part of Figure 5). The breakdown is based primarily on data derived from the 2001 Census with the same shares projected over the future. Special tabulations were required. The exception is income since the census includes no income data. Instead the national full-time earnings distribution from the British Household Panel Survey (BHPS) is used. The BHPS is used in estimating the headship rates below.

Figure 5: **The Population Table (PopnSE)** *(continued)*





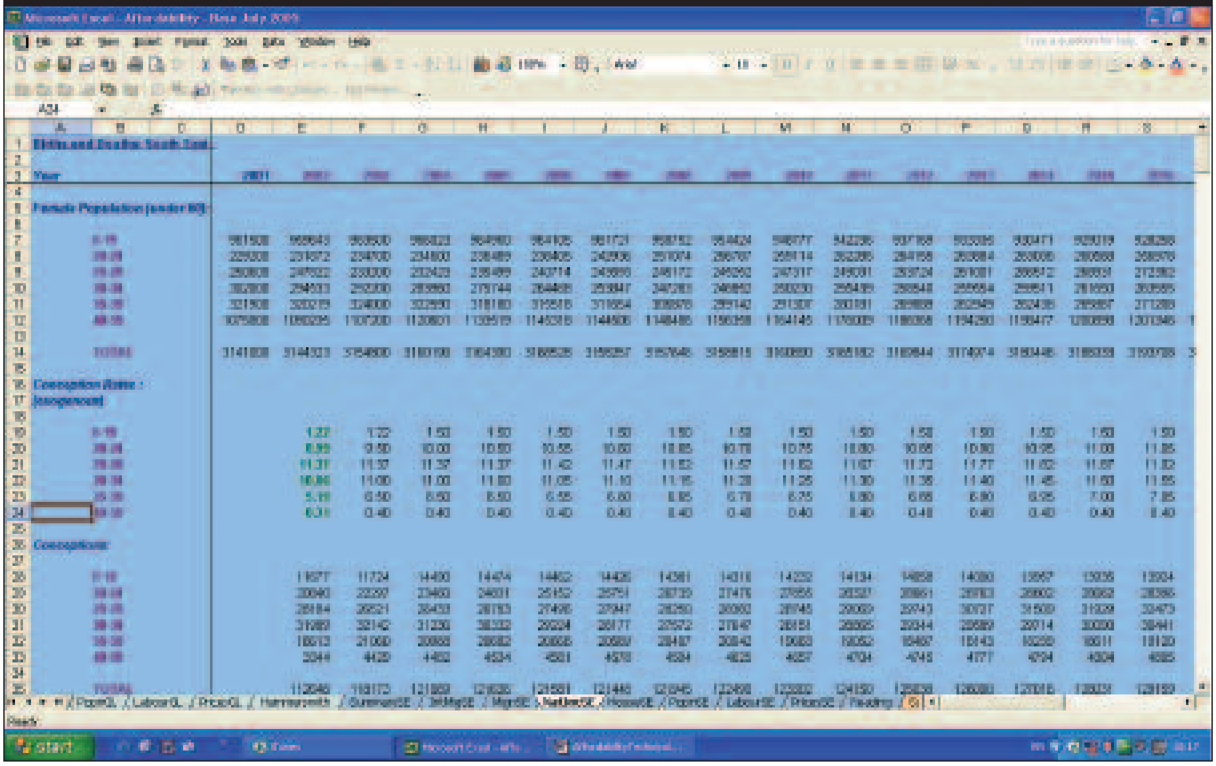
The Natural Rate of Increase

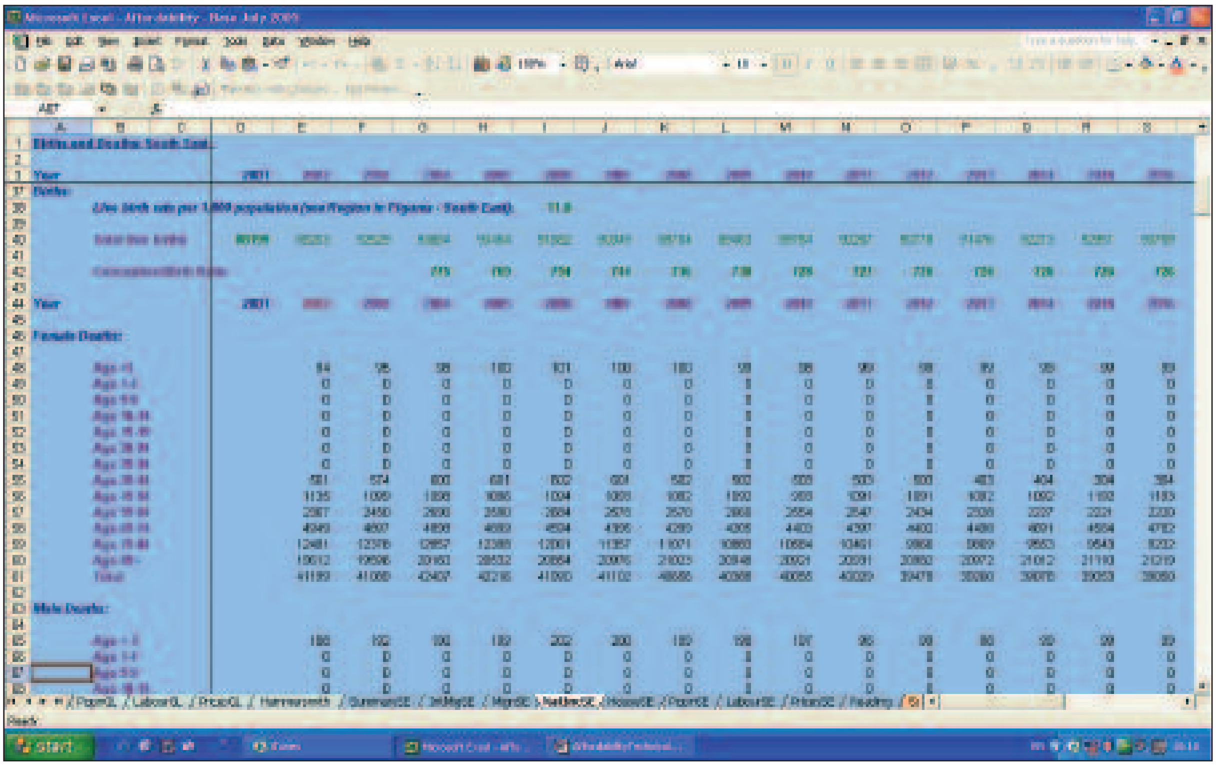
This worksheet determines births and deaths. The age distribution of the female population, determined in (**PopnSE**), is applied to exogenously given conception rates (taken from *Health Statistics Quarterly*). In principle, both the conception and death rates could be endogenised within the model. However, since the responsiveness of these variables to changes in housing construction is likely to be small, this is a simplification that is unlikely to have a significant effect on the overall results.

Multiplying population by conception rates gives an estimate of the total number of conceptions rather than births. Therefore, as the second part of Figure 6 shows, births are derived as proportions of conceptions. These proportions are considerably less than one, reflecting miscarriages as well as terminations.

Similarly, total deaths, disaggregated by age and by gender, are obtained by applying death rates to the population of each age/gender. The death rate projections to 2031 are consistent with those underlying the official 2003-based population projections. Although deaths in the first year are significant and vary by region, projected deaths in the youngest age groups are small.

Figure 6: **Natural Increase (NatIncSE)**



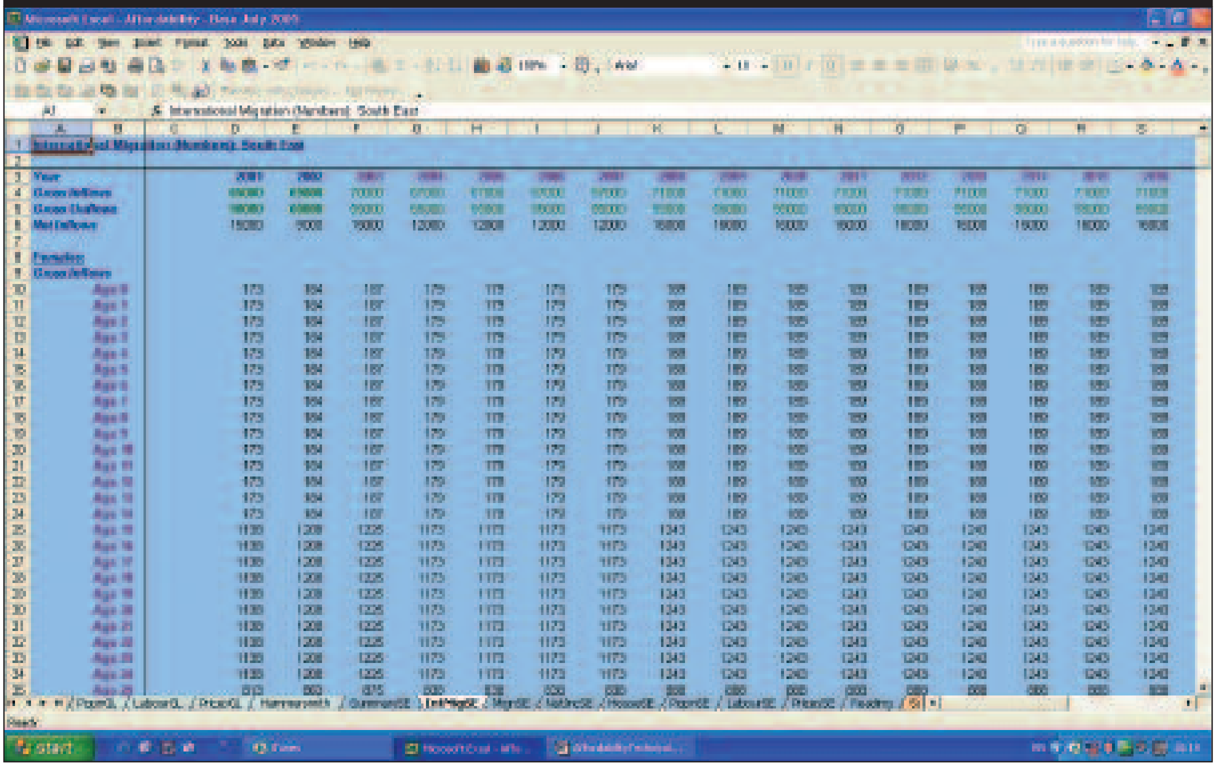


International Migration

This worksheet, Figure 7, determines gross international inflows and outflows determined by single age. This degree of detail is necessary to feed into the population worksheet. However, data on international migration flows are notoriously poor and formal modelling was not feasible at this stage of the model's development. Historical figures were obtained from *Regions in Figures* and the aggregate gross flows projections were taken from the 2003-based population projections for each region. These can be seen in rows 4 and 5 of Figure 7.

To the aggregate projections, a predetermined age distribution of migration flows is applied, derived from *Population Trends*. This distribution refers to the country as a whole, rather than varying by region. Migration flows are heavily weighted towards the younger age groups, since moving propensities fall sharply above the age of 40. International (but not inter-regional) flows are assumed to be zero over the age of 60 as a simplification.

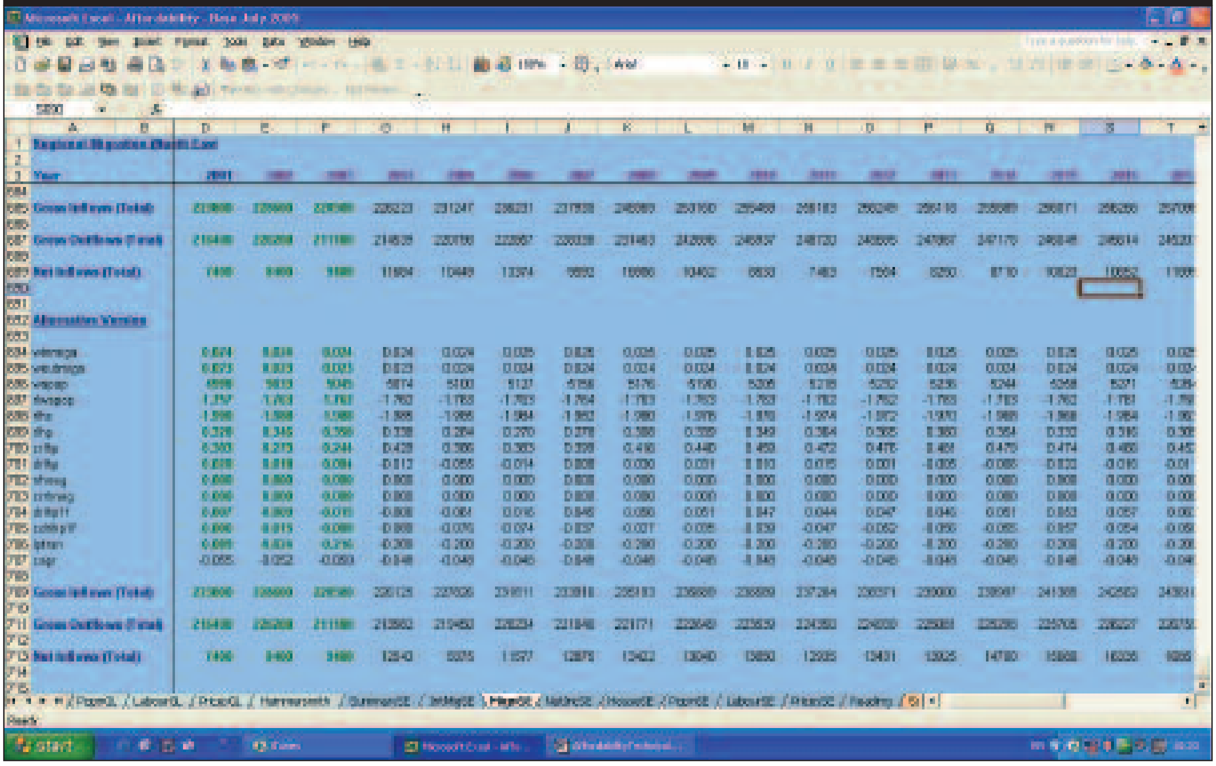
Figure 7: **International Migration (IntMigSE)**



Inter-Regional Migration

Inter-regional migration is the first worksheet where fully estimated equations come into play. As noted above, there are, in fact, two versions of the equations. The basic gross migration data are taken from *Population Trends*, derived from the National Health Service Central Register.

Figure 8: **Inter-Regional Migration (MignSE)**



In Figure 8, Version 2 of the model is used – the simpler equation set. When Version 1 is used, the gross inflows equation is defined in row 709 and outflows in row 711. However the underlying estimated equations are given in rows 694 (**winmiga**) and row 695 (**woutmiga**). Rows 696-707 define the terms that feed into the two flow variables.

When Version 1 is used, the switch ensures that the values in rows 685-687 are the same as in rows 709-711. This is because, in this version of the model, the two are linked by simple identities (row 685=row 709 and row 687=row 711). However, in Version 2 of the model, these identities are overwritten and alternative estimated versions for the flows inserted into rows 685 and 687. In Version 2, rows 694-713 become redundant.

Whichever version of the equations is used, the aggregate flows are broken down by age (not shown in Figure 8), using a pre-determined age distribution. Once again, the migration flows are weighted towards the more mobile younger age groups. Because of sample sizes, a national age distribution is applied to each region.

The Migration Equations in Version 1

An important point needs to be noted that affects all the estimated equations in the model. Because of the switch from Standard Statistical Regions to Government Office Regions, it is not possible to construct long time series for many of the variables. To overcome this problem, the South East and East Anglia (SSR basis) were combined and the South East and East regions (GOR basis) were combined to derive consistent series. A similar aggregation occurred for the North East and North West. But, of course, the model requires the disaggregated regions. Therefore, the "slope" coefficients are assumed to be the same for the East and South East with the equation constants adjusted for scale. Also, as noted below, spatial contiguity terms are important for many of the equations in Version 1. This caused some difficulties for the model. For example, behaviour in the East might depend on behaviour in the South East. But the two regions have been consolidated in estimation and, therefore, there is no spill over in estimation. We had to make a judgement on the structure of these contiguity effects in model construction, which strictly is not consistent with the estimated results. However, we doubt whether this introduces major errors, although there is no way to test it formally. The dependent variable (**winmiga**, **woutmiga**) to be modelled for each region (i) is defined as:

(gross in (or out) migration/working age population)/(sum of gross migration across UK regions/UK working age pop). The denominator is divided by its 1990 value so that the mean dependent variable is close to its unscaled value. The logic of the model is the same as that of Cameron and Muellbauer (1998). The following features were found in estimation:

(i) The sensitivity of migration varies with housing turnover, (lptran in row 706).

(ii) The possibility of commuting rather than migration suggests that labour market conditions in contiguous regions help to attract migrants to region i in a similar way to conditions within region i. This is the *minus lambda1* effect in the equations.

(iii) However, housing market conditions in contiguous regions, e.g. house prices, have the opposite effect: if house prices in region i are high, potential migrants can move to a contiguous region with lower prices and have a commuting option to region i. This is the *plus lambda1* effect in the equations. We can accept the hypothesis that the two opposite effects can be captured by the same coefficient.

The precise form of the equations is as follows, which can be related to the variables in rows 694-707 of Figure 8. It should be noted that throughout Version 1 of the model "." After a mnemonic Indicates a regionally varying term, e.g "." Would be replaced by "SW" for the South West. "ST" refers to the South (the sum of SE and E) and "NT" to the North (the sum of NW and NE). Some coefficients are constant over the equations, whereas others are regional specific. "c" at the start of a variable mnemonic generally indicates a spatial contiguity variable, e.g. "crur" denotes unemployment in spatially contiguous regions.

Inflow equations for region (i) in time (t)

winmiga. = a0in_.
    Comment: region fixed effect

+ m1in_in * winmiga.(-1)
    Comment: lagged dependent variable;

+ (1+d1* lptran).*

Comment: coefficient on the economic part of the model varies with the log rate of property transactions, lptran.

[m0in_. +

Comment: note second fixed effect needed since the means of some of the regressors in the square bracket could be far from zero.

e0in * {rlwapop.(-1) -rlhs.(-1)}

Comment: this is log working age population – log housing stock: with e0in negative, the more houses relative to population, the higher the inflow, other things being equal. One might have expected a contiguity effect: if there are more houses relative to population in the contiguous region, then the inflow to this region might be lower, since people can chose to locate in the neighbouring region, and potential migrants from neighbouring regions are more likely to stay there. However, the results are better without such an effect.

+ a1in * {drur. – lambda1 * (drur. – cdrur.)}
+ a2in * {rur.(-1) – lambda1 * (rur.(-1) – crur.(-1))}

Comment: the unemployment effects in change and level form. In the inflow equation, the change in unemployment matters more (outside London: in London, both matter). The unemployment rates seem to capture labour market effects better than the employment rates. Note the contiguity effects: with lambda1 positive, labour market conditions in neighbouring regions have the same sign effect on in- migration, since people have a commuting option.

+ a4in * {rlfte. – lambda1 * (rlfte. – crlfte.)}

Comment: relative log earnings with a contiguity effect of the type applying to unemployment rates.

+ a5in * {apr.(-1) – lambda1 * (apr.(-1) – capr.(-1))}

Comment: regions with relatively high employment proportions in the industrial sector (apr) tend to attract fewer migrants, as this sector remains in long term relative decline.

– a7in * {rlhp. + lambda1 * (rlhp. – crlhp.)}

Comment: relative house price effect. Note the contiguity effect works in the opposite direction of the labour market contiguity effect: high relative house prices in contiguous regions attract migrants to this region since they can live in this region and commute.

+ a6cin * {drlhp. + lambda1 * ((rlhp. – crlhp.) – (rlhp.(-1) – crlhp.(-1)))}**3

Comment: cubic in rate of change in relative house prices suggesting that high turnover associated with rapid rates of appreciation is linked with high in migration.

+ a9in * (rrhneg. – rrhneggb)
+ a10in * (rrhneg. – crrhneg.)

Comment: downside risk term – negative rate of return has negative effect on in migration. The contiguity effect is negative, consistent with labour market contiguity story rather than housing market story, perhaps because main effect is on negative labour market implications of such negative shocks. However, this is relative small effect.

+ a14in * {drlhp1f. + lambda1 * (drlhp1f. – cdrlhp1f.)}

Comment: expected appreciation in relative house prices. Note contiguity effect.

+ ttin_. * (YEAR-1990)]

Comment: region specific trend.

It is often the case in Version 1 that London was found to give rather different results. In the inflows equation the Greater London equation has exactly the same structure except that e0in, a1in, a2in, a4in are allowed to take on values different from those in other regions. Intercepts and the trend are, additionally, region specific.

The parameter estimates are given in the following table. Estimation is on annual data covering the period 1977 to 2003 using Seemingly Unrelated Regression.

Parameter	Estimate	Standard Error	t-statistic	P-value
A0IN_NT	.018606	.123261E-02	15.0949	[.000]
M1IN_IN	.030784	.048410	.635911	[.525]
M0IN_NT	–.452906E-02	.987806E-03	–4.58497	[.000]
E0IN	–.022008	.563864E-02	–3.90316	[.000]
A1IN	–.465915E-03	.103732E-03	–4.49152	[.000]
A4IN	.580961E-02	.376031E-02	1.54498	[.122]
A5IN	–.017085	.875615E-02	–1.95123	[.051]
A7IN	.203469E-02	.598635E-03	3.39889	[.001]
A6CIN	.125071	.036423	3.43386	[.001]
A9IN	.271716E-02	.139102E-02	1.95336	[.051]
A14IN	.294490E-02	.835125E-03	3.52630	[.000]
TTIN_NT	.489761E-04	.204991E-04	2.38919	[.017]
A0IN_YH	.024332	.153635E-02	15.8377	[.000]
M0IN_YH	–.507113E-02	.112753E-02	–4.49755	[.000]
TTIN_YH	.117335E-03	.235247E-04	4.98774	[.000]
A0IN_WM	.021434	.114457E-02	18.7264	[.000]
M0IN_WM	–.293065E-02	.890002E-03	–3.29286	[.001]
TTIN_WM	.681086E-04	.179232E-04	3.80003	[.000]
A0IN_EM	.024361	.142612E-02	17.0819	[.000]
M0IN_EM	.155532E-02	.121421E-02	1.28093	[.200]
TTIN_EM	.209616E-03	.194664E-04	10.7681	[.000]
A0IN_ST	.020417	.120353E-02	16.9642	[.000]
M0IN_ST	.364670E-02	.618977E-03	5.89149	[.000]
TTIN_ST	–.190615E-04	.121779E-04	–1.56525	[.118]
A0IN_GL	.029943	.201409E-02	14.8667	[.000]
M0IN_GL	–.013910	.247147E-02	–5.62816	[.000]
E0INGL	–.052481	.495521E-02	–10.5910	[.000]
A1INGL	–.229984E-02	.284905E-03	–8.07230	[.000]
A2INGL	–.956501E-03	.136251E-03	–7.02015	[.000]
A4INGL	.062526	.010105	6.18767	[.000]
A7INGL	.317232E-02	.114040E-02	2.78177	[.005]
TTIN_GL	–.221154E-03	.615782E-04	–3.59143	[.000]
A0IN_SW	.023268	.153102E-02	15.1977	[.000]
M0IN_SW	.417456E-02	.106474E-02	3.92074	[.000]
TTIN_SW	.131002E-03	.243115E-04	5.38849	[.000]

Outflow equations for region (i) in time (t)

The out migration equations have almost the same structure:

woutmiga. = a0out_.
+ m1out_out * woutmiga.(-1)
+ (1+d1* lptran).*
[m0out_.
+ e0out * {rlwapop.(-1) -rlhs.(-1)}
+ a1out * {drur. – lambda1 * (drur. – cdrur.)}

+ a2out * {rur.(-1) – lambda1 * (rur.(-1) – crur.(-1))}
+ a4out * {rlfte. – lambda1 * (rlfte. – crlfte.)}
+ a5out * {apr.(-1) – lambda1 * (apr.(-1) – capr.(-1))}
– a7out * {rlhp. + lambda1 * (rlhp. – crlhp.)}
+ a6cout * {drlhp. + lambda1 * ((rlhp. – crlhp.) – (rlhp.(-1) – crlhp.(-1)))}**3
+ a9out * (rrhneg. – rrhneggb)
+ a10out * (rrhneg. – crrhneg.)
+ a14out * {drlhp1f. + lambda1 * (drlhp1f. – cdrlhp1f.)}
+ ttout_. * (YEAR-1990)]

Greater London equation has exactly the same structure except that a1out is allowed to take on values different from those in other regions. The other coefficients for GL are similar to those for other regions. Intercepts and trend are region specific.

Parameter	Estimate	Standard Error	t-statistic	P-value
A0OUT_NT	.011057	.102052E-02	10.8346	[.000]
M1OUT_OUT	.407422	.042265	9.63962	[.000]
M0OUT_NT	–.178E-02	.754285E-03	–2.35982	[.018]
E0OUT	.011948	.272243E-02	4.38862	[.000]
A2OUT	.133721E-03	.346539E-04	3.85877	[.000]
A4OUT	–.452738E-02	.195605E-02	–2.31455	[.021]
A5OUT	.602843E-02	.585259E-02	1.03004	[.303]
A7OUT	–.729251E-03	.336987E-03	–2.16403	[.030]
A9OUT	–.258817E-02	.782442E-03	–3.30781	[.001]
A14OUT	–.308229E-02	.593190E-03	–5.19613	[.000]
TTOUT_NT	.394581E-05	.152222E-04	.259213	[.795]
A0OUT_YH	.014257	.115697E-02	12.3229	[.000]
M0OUT_YH	–.287904E-02	.726411E-03	–3.96338	[.000]
TTOUT_YH	.303560E-04	.156965E-04	1.93393	[.053]
A0OUT_WM	.012930	.102693E-02	12.5910	[.000]
M0OUT_WM	–.218054E-02	.649557E-03	–3.35696	[.001]
TTOUT_WM	.748615E-04	.128253E-04	5.83703	[.000]
A0OUT_EM	.015131	.122369E-02	12.3650	[.000]
M0OUT_EM	–.198258E-02	.835471E-03	–2.37300	[.018]
TTOUT_EM	.633394E-04	.153646E-04	4.12241	[.000]
A0OUT_ST	.012754	.106759E-02	11.9464	[.000]
M0OUT_ST	.325322E-03	.562818E-03	.578023	[.563]
TTOUT_ST	.513768E-04	.112415E-04	4.57029	[.000]
A0OUT_GL	.016518	.161880E-02	10.2036	[.000]
M0OUT_GL	.247292E-02	.107806E-02	2.29385	[.022]
A1OUTGL	.132113E-02	.252759E-03	5.22684	[.000]
TTOUT_GL	.169419E-04	.238646E-04	.709919	[.478]
A0OUT_SW	.016858	.129478E-02	13.0204	[.000]
M0OUT_SW	–.205313E-02	.615326E-03	–3.33665	[.001]
TTOUT_SW	.567626E-05	.136571E-04	.415628	[.678]

The Migration Equations in Version 2

The migration equations in the second version are much simpler, although the ideas behind the two sets are not fundamentally different. In Version 1, house prices, unemployment and earnings are the key variables, generally both in levels and rates of change. Spatial contiguity effects are also very important. Version 2 also stresses house prices (although there are no terms in the rate of change), relative unemployment rates, (although there are no relative earnings variables) and housing availability. Contiguity is captured through the house price interactions. Estimation is by SUR.

The estimation sample period is considerably shorter than for Version 1 – data begin in 1990. This allows consistent series to be constructed on a GOR basis. Therefore, in contrast to Version 1, separate equations can be estimated for the South East, East, North West and North East. The shorter sample, obviously, presents difficulties in estimation. However, in order, to improve the efficiency of the estimates, coefficient equality across the equations can be tested and imposed where appropriate. Therefore, space as well as time increases the degrees of freedom in estimation. Previous work on house prices, Meen (1999), indicates that England can be divided into three meta regions (plus London) – the South, the Midlands and the North, This categorisation provides blocs that can be used in estimation (with potential coefficient equality)[2]. The use of SUR in estimation is a way of capturing spatially correlated errors.

2 In fact, in estimation, the Midlands and the North are combined, although the coefficients are not necessarily equal.

The general form of the equations is:

$$MINR_i = a(1)+a(2)*MINR_i(-1)+a(3)*DU_i(-1)+a(4)*DDU_i + a(5)*LPH_i/LPH_{gl}+a(6)*SCOMP_i + a(7)*RBM$$

$$MIOUTR_i = b(1)+b(2)*MOUTR_i(-1)+b(3)*DU_i(-1)+b(4)*DDU_i + b(5)*LPH_i/LPH_{gl}+b(6)*SCOMP_i + b(7)*RBM$$

where:

MINR = gross in-migration/resident population

MOUTR = gross out-migration/resident population

DU = change in unemployment (relative to GB)

DDU = rate of change in unemployment (relative to GB)

LPH = logarithm of nominal house price index (mix-adjusted)

LPH_{gl} = logarithm of London house price index

SCOMP = regional private housing completions (as a share of that in the appropriate meta region).

RBM = nominal mortgage interest rate

Therefore, the inflows and outflows equations contain the same terms. In line with other findings in the literature, some terms, e.g. unemployment, have the same signs in both equations. This ensures that the gross flows are much bigger than the net flow, but the overall effect of any variable has to be obtained from the sum of the two coefficients. In the equations above, house prices are expressed relative to those in London. In fact, this only holds for the southern regions. The price denominator in the other regions is the UK average. Arguably, prices in the other regions might also use London or South East prices as the denominator. However, despite the well-documented move of migrants from the North to the South, in fact, most moves are short distance and the UK average may be more appropriate. The housing completions term attempts to capture housing availability. In fact, this turns out to be significant only in the southern regions. The proportional specification is more appropriate than the regional levels. This means that an equal increase in construction in each of the regions has no effect on migration flows, except through the price terms. But "unbalanced" increases in construction can have a major effect on migration flows. As a result, improvements in affordability arising from increases in construction are partly offset. This is why the simulations in the main report are "balanced".

The detailed estimation results are given in the following tables.

System: **South East, East, South West**
Estimation Method: Seemingly Unrelated Regression
Total system (balanced) observations 72

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.011205	0.002925	3.830608	0.0004
C(2)	0.344298	0.089275	3.856603	0.0004
C(3)	–0.003036	0.000452	–6.719375	0.0000
C(4)	–0.001226	0.000430	–2.850398	0.0065
C(5)	–0.002611	0.001093	–2.388360	0.0211
C(8)	0.014623	0.004082	3.581928	0.0008
C(25)	–0.000346	7.67E-05	–4.507935	0.0000
C(9)	0.019405	0.003803	5.102616	0.0000
C(10)	0.158553	0.126068	1.257683	0.2149
C(26)	–0.000202	0.000105	–1.919644	0.0611
C(11)	0.005810	0.003087	1.881737	0.0662
C(12)	0.608529	0.091956	6.617637	0.0000
C(13)	0.002399	0.002233	1.074354	0.2883
C(14)	0.975399	0.075138	12.98138	0.0000
C(15)	–0.001228	0.000287	–4.282552	0.0001
C(16)	–0.000874	0.000199	–4.400677	0.0001
C(17)	0.002463	0.000679	3.630417	0.0007
C(20)	–0.006532	0.002079	–3.142144	0.0029
C(27)	–0.000193	4.38E-05	–4.406765	0.0001
C(29)	–0.001650	0.000242	–6.826892	0.0000
C(21)	0.004204	0.002161	1.945092	0.0579
C(22)	0.832831	0.102903	8.093391	0.0000
C(30)	–0.001086	0.000172	–6.320276	0.0000
C(23)	0.007147	0.002376	3.008399	0.0042
C(24)	0.779701	0.092134	8.462695	0.0000
C(31)	–0.000862	0.000168	–5.113328	0.0000

Equation: MINRSE=C(1)+C(2)*MINRSE(-1)+C(3)*DUSE(-1)+C(4)
*DDUSE+C(5)*LPHSEGL+C(8)*SCOMPSE +C(25)*RBM

R-squared	0.897790	Mean dependent var	0.028283
Adjusted R-squared	0.775138	S.D. dependent var	0.000793
S.E. of regression	0.000376	Sum squared resid	7.06E-07
Durbin-Watson stat	2.442891		

Equation: MINRSW=C(9)+C(10)*MINRSW(-1)+C(3)*DUSW(-1)+C(4)
*DDUSW+C(5)*LPHSWGL+C(8)*SCOMPSW +C(26)*RBM

R-squared	0.848004	Mean dependent var	0.028378
Adjusted R-squared	0.665609	S.D. dependent var	0.001247
S.E. of regression	0.000721	Sum squared resid	2.60E-06
Durbin-Watson stat	2.152490		

Equation: MINRE=C(11)+C(12)*MINRE(-1)+C(3)*DUE(-1)+C(4)*DDUE
+C(5)*LPHEGL+C(8)*SCOMPE+C(25)*RBM

R-squared	0.918136	Mean dependent var	0.026615
Adjusted R-squared	0.819900	S.D. dependent var	0.001193
S.E. of regression	0.000506	Sum squared resid	1.28E-06
Durbin-Watson stat	3.125956		

Equation: MOUTRSE=C(13)+C(14)*MOUTRSE(-1)+C(15)*DUSE(-1)
+C(16)*DDUSE+C(17)*LPHSEGL+C(20)*SCOMPSE +C(27)*RBM
+C(29)*DUM03

R-squared	0.937255	Mean dependent var	0.025957
Adjusted R-squared	0.827451	S.D. dependent var	0.000997
S.E. of regression	0.000414	Sum squared resid	6.86E-07
Durbin-Watson stat	2.303709		

Equation: MOUTRSW=C(21)+C(22)*MOUTRSW(-1)+C(15)*DUSW(-1)
+C(16)*DDUSW+C(17)*LPHSWGL+C(20)*SCOMPSW +C(30)
*DUM03

R-squared	0.878052	Mean dependent var	0.022435
Adjusted R-squared	0.731715	S.D. dependent var	0.000638
S.E. of regression	0.000330	Sum squared resid	5.45E-07
Durbin-Watson stat	3.025879		

Equation: MOUTRE=C(23)+C(24)*MOUTRE(-1)+C(15)*DUE(-1)+C(16)
*DDUE+C(17)*LPHEGL+C(20)*SCOMPE+C(27)*RBM+C(31)
*DUM03

R-squared	0.922737	Mean dependent var	0.023258
Adjusted R-squared	0.787526	S.D. dependent var	0.000628
S.E. of regression	0.000289	Sum squared resid	3.35E-07
Durbin-Watson stat	2.694359		

System: **Greater London**
Estimation Method: Least Squares
Sample: 1991 2003
Total system (unbalanced) observations 25

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(32)	0.015515	0.001902	8.156134	0.0000
C(33)	0.198653	0.064409	3.084220	0.0095
C(35)	–0.004040	0.000235	–17.20337	0.0000
C(36)	–0.016642	0.000990	–16.80602	0.0000
C(37)	0.024566	0.004024	6.104701	0.0001
C(38)	–0.000337	4.92E-05	–6.840988	0.0000
C(39)	–0.004542	0.000315	–14.40441	0.0000
C(48)	–0.000800	0.000137	–5.837285	0.0001
C(40)	0.035780	0.002526	14.16740	0.0000
C(42)	–0.001734	0.000488	–3.551046	0.0040
C(45)	0.023354	0.010436	2.237904	0.0450
C(46)	–0.000894	9.84E-05	–9.084068	0.0000
C(49)	0.001843	0.000652	2.824939	0.0153

Equation: MINRGL= C(32)+C(33)*MINRGL(-1)+C(35)*DDUGL+C(36)
*LPHGLUK+C(37)*SCOMPGL+C(38)*RBM+C(39)*DUM03+ C(48)
*DUM97

R-squared	0.997840	Mean dependent var	0.022969
Adjusted R-squared	0.994060	S.D. dependent var	0.001435
S.E. of regression	0.000111	Sum squared resid	4.89E-08
Durbin-Watson stat	2.300808		

Equation: MOUTRGL= C(40)+C(42)*DUGL(-1)+C(45)*SCOMPGL+C(46)
*RBM+ C(49)*DUM97

R-squared	0.952147	Mean dependent var	0.031813
Adjusted R-squared	0.928221	S.D. dependent var	0.002108
S.E. of regression	0.000565	Sum squared resid	2.55E-06
Durbin-Watson stat	2.039242		

System: **East Midlands, West Midlands, Yorks & Humberside, North East, North West**
Estimation Method: Seemingly Unrelated Regression
Sample: 1992 2003
Total system (balanced) observations 120

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.007755	0.000786	9.868104	0.0000
C(2)	0.725013	0.029741	24.37767	0.0000
C(4)	–0.001545	7.89E-05	–19.58361	0.0000
C(5)	–0.007371	0.000960	–7.679227	0.0000
C(16)	0.005083	0.000527	9.640966	0.0000
C(8)	0.010346	0.000656	15.77022	0.0000
C(9)	0.520949	0.032860	15.85362	0.0000
C(11)	–0.000253	5.08E-05	–4.974937	0.0000
C(12)	–0.001504	0.000349	–4.309475	0.0000
C(14)	–0.000154	1.47E-05	–10.53788	0.0000
C(15)	0.008671	0.000546	15.88129	0.0000
C(17)	0.008663	0.000553	15.67267	0.0000
C(18)	0.003240	0.000599	5.412195	0.0000
C(23)	0.859777	0.026207	32.80652	0.0000
C(25)	–0.000422	0.000103	–4.110653	0.0001
C(26)	0.002287	0.000488	4.688431	0.0000
C(19)	0.002746	0.000495	5.548143	0.0000
C(20)	0.004723	0.000616	7.661095	0.0000
C(29)	0.746393	0.032291	23.11471	0.0000
C(31)	0.000435	5.50E-05	7.911517	0.0000
C(32)	0.001788	0.000278	6.424181	0.0000
C(21)	0.003955	0.000533	7.414496	0.0000
C(22)	0.002767	0.000593	4.668530	0.0000
C(38)	0.000456	5.38E-05	8.482092	0.0000

Equation: MINREM=C(1)+C(2)*MINREM(-1)+C(4)*DDUEM+C(5)
*LPHEMUK

R-squared	0.925398	Mean dependent var	0.025797
Adjusted R-squared	0.897423	S.D. dependent var	0.001815
S.E. of regression	0.000581	Sum squared resid	2.70E-06
Durbin-Watson stat	2.116873		

Equation: MINRWM=C(16)+C(2)*MINRWM(-1)+C(4)*DDUWM+C(5)
*LPHWMUK

R-squared	0.909323	Mean dependent var	0.017346
Adjusted R-squared	0.875319	S.D. dependent var	0.000887
S.E. of regression	0.000313	Sum squared resid	7.86E-07
Durbin-Watson stat	2.246904		

Equation: MINRYH=C(8)+C(9)*MINRYH(-1)+C(11)*DDUYH+C(12)
*LPHYHUK+C(14)*RBM

R-squared	0.940848	Mean dependent var	0.018732
Adjusted R-squared	0.907047	S.D. dependent var	0.000899
S.E. of regression	0.000274	Sum squared resid	5.25E-07
Durbin-Watson stat	2.556065		

Equation: MINRNW=C(15)+C(9)*MINRNW(-1)+C(11)*DDUNW+C(12)
*LPHNWUK +C(14)*RBM

R-squared	0.886661	Mean dependent var	0.015303
Adjusted R-squared	0.821896	S.D. dependent var	0.000641
S.E. of regression	0.000270	Sum squared resid	5.12E-07
Durbin-Watson stat	1.617857		

Equation: MINRNE=C(17)+C(9)*MINRNE(-1)+C(11)*DDUNE+C(12)
*LPHNEUK +C(14)*RBM

R-squared	0.911775	Mean dependent var	0.015291
Adjusted R-squared	0.861360	S.D. dependent var	0.000754
S.E. of regression	0.000281	Sum squared resid	5.52E-07
Durbin-Watson stat	2.484059		

Equation: MOUTREM=C(18)+C(23)*MOUTREM(-1)+C(25)*DDUEM
+C(26)*LPHEMUK

R-squared	0.847730	Mean dependent var	0.022576
Adjusted R-squared	0.790628	S.D. dependent var	0.001013
S.E. of regression	0.000464	Sum squared resid	1.72E-06
Durbin-Watson stat	1.498194		

Equation: MOUTRWM=C(19)+C(23)*MOUTRWM(-1)+C(25)*DDUWM
+C(26)*LPHWMUK

R-squared	0.897206	Mean dependent var	0.018862
Adjusted R-squared	0.858658	S.D. dependent var	0.000764
S.E. of regression	0.000287	Sum squared resid	6.60E-07
Durbin-Watson stat	2.513354		

Equation: MOUTRYH=C(20)+C(29)*MOUTRYH(-1)+C(31)*DDUYH
+C(32)*LPHYHUK

R-squared	0.879107	Mean dependent var	0.019110
Adjusted R-squared	0.833772	S.D. dependent var	0.000774
S.E. of regression	0.000316	Sum squared resid	7.97E-07
Durbin-Watson stat	1.954233		

Equation: MOUTRNW=C(21)+C(29)*MOUTRNW(-1)+C(31)*DDUNW
+C(32)*LPHNWUK

R-squared	0.773307	Mean dependent var	0.016342
Adjusted R-squared	0.688297	S.D. dependent var	0.000638
S.E. of regression	0.000356	Sum squared resid	1.01E-06
Durbin-Watson stat	2.619886		

Equation: MOUTRNE=C(22)+C(29)*MOUTRNE(-1)+C(38)*DUNE(-1)
+C(31)*DDUNE+C(32)*LPHNEUK

R-squared	0.813167	Mean dependent var	0.016789
Adjusted R-squared	0.706406	S.D. dependent var	0.000510
S.E. of regression	0.000276	Sum squared resid	5.35E-07
Durbin-Watson stat	3.175979		

Household Formation

As described in the final report, a novelty of the model is its combination of econometric results from aggregate, time-series data and micro, panel data (BHPS). The latter are used to model household formation for the under 35s. The model is based on an updating of the work in Andrew and Meen (2003). In both the earlier and current work, results were obtained from a joint model of household formation and tenure choice, although only the household formation part appears in the model[3]. One of the important findings, which is in line with most of the literature, is that demographic variables are crucial to the determination of household formation, with economic variables (housing costs and incomes) playing a modest role, whereas economic variables are more important in the determination of tenure. Consequently, it is important that the demographic characteristics information, which can be obtained from **PopnSE**, is incorporated fully into estimation. This cannot be done adequately from time-series estimation, but can from micro data.

The table below gives the results from the bivariate probit model (just the household formation components). The importance of the demographic variables stands out. But housing costs, incomes and unemployment are also included. The housing cost term is barely significant (although slightly more significant in other versions). Therefore, we expect the price elasticities of household formation to be low.

Note, however, that except for regional dummies in the East and South East, the coefficients are not regionally varying. However, the *aggregate* elasticities will still vary between regions, because of the different populations falling into each group. The Final Report highlighted the impact of the younger age distribution in London, which raises the aggregate price elasticity in that area.

Bivariate Probit Model – Household Formation Element

Variable	Coefficient	z-value
Male	–0.1122	3.4
Race – 3	–0.6391	5.5
Ageband – 1	0.3029	6.3
Ageband – 2	0.6382	11.8
Ageband – 3	0.9755	16.6
Lspouse	1.254	38.7
Acqsp – 1	2.265	42.2
Acqsp – 2	–1.316	30.8
Kid – 1	0.5159	13.9
Lparent – 1	–1.733	57.0
Interest	–0.000030	1.9
Lrinc	0.2299	9.6
ILOun	–0.0282	2.5
Student	0.1424	2.7
Region – 2-3	–0.1751	3.8
Constant	0.3443	2.3

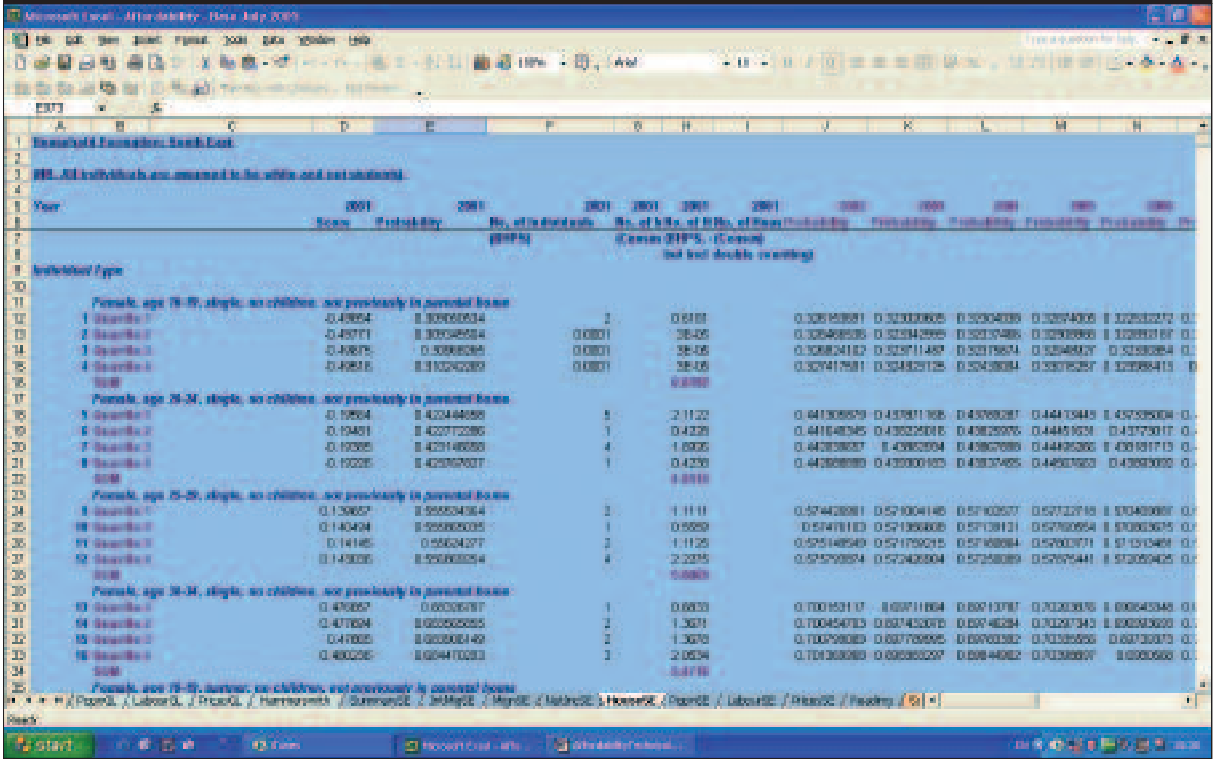
Equation also includes yearly dummies

3 Strictly, the tenure choice element does appear in the model. But it is not necessary for the solution of the model and further testing would be required if this were to be used.

Variable Names	Description
Race	Omitted Category is White 2 = Black 3 = Asian 4 = Other
Male;	Gender – Omitted Category: Female
Ageband	Dummies: Omitted under 20 Band1 = 20-24 Band2 = 25-29 Band3 = 30-34 Band4 = 35-39
Lrinc	Real Income (/1000) (t-1)
Lspouse Acqsp	1 = partner present (t-1) 1 = new spouse 2 = separated/divorced/widowed Default: single across two waves
Kid	Dummy Variable for Kid = 1
Lparent	Parent present (t-1)
Interest	Mortgage costs: Mortgage interest rate*regional house price/consumers' expenditure deflator
ILOun	ILO regional unemployment rate
Region	Omitted = London 2= SE 3 = EA 4 = SW 6 = EM 7 = WM 9 = NW 12 = Yorks/Humberside 15 = NE

The coefficients are translated into "scores" in Figure 9 below, first, for 2001. The scores are calculated for 256 individual types. Using the normal distribution, these are, then, converted into probabilities of household formation in column E for 2001. Probabilities for subsequent years can be derived using the projections of macroeconomic variables, given in rows 398-404. The most important of these is "interest payments", since this is based on the house price projections coming from the other worksheets. Therefore, a change in new construction affects prices, which feeds into household formation.

Figure 9: **Household Formation (HouseSE)**



The probabilities are multiplied by the number of individuals falling into each category to obtain the total number of households, allowing for the double counting of individuals with partners. This is carried out in rows 816-936. Note that the probabilities distinguish between those who were previously living with parents in the previous wave and those who were not. The probabilities are much higher for the latter group. However, there is no distinction between the two in the census and, hence, an approximation has to be made in order to obtain the total number of households by age/gender/marital status/children.

The total for each group (i) is defined as:

$$H = Pr_N * H_{-1}/Pr_{N-1} + Pr_W * (\Delta X) \qquad (1)$$

where:

H = total number of households in group (i)

Pr_N = probability of forming an independent household for an individual in group (i), not living with a parent in the previous wave.

Pr_W = probability of forming an independent household for an individual in group (i), living with a parent in the previous wave.

X = total population in group (i)

In the above, the (i) subscripts have been suppressed for convenience. Hence the total number of households is derived from a weighted average. The derivation is given below, highlighting why the approximation is needed.

Let: X_1 = number of individuals not living with a parent in the previous wave and X_2 = number of individuals living with parents in the previous wave.

$X = X_1 + X_2$.

Therefore:

$H = Pr_N * X_1 + Pr_W * X_2$ or:
$H = Pr_w * X + (Pr_N – Pr_w) * X_1$ (2)

But the problem is that X1 is unobserved. Now compare this with the model equation (1) above. Two approximations are possible:

(a) $H_{-1}/Pr_{N-1} \approx X_{-1}$
(b) $H\text{-}1/Pr_{N-1} \approx X_{1-1}$

Under (a), the model equation becomes:

$H = Pr_w * X + (Pr_N – Pr_w) * X_{-1}$ (3)

Comparing (3) with (2), the approximation is that: $X_{-1} = X_1$, which is not too bad since the majority of the individuals are not living with parents after they reach adulthood.

Under (b), the model equation is:

$H = Pr_w * X + (Pr_N – Pr_w) * X_{1-1} - Pr_w * (X_{-1} – X_{1-1})$ (4)

In this case, the approximation to (2) requires: $X_1 = X_{1-1}$ (which holds in equilibrium) and $X_{-1} = X_{1-1}$ (which is reasonable for the same reason as in (3)).

As noted earlier, the bivariate probit has only been estimated for the population under 35. In fact, most of the literature concentrates on the younger age groups on the grounds that they are more susceptible to demographic and economic change. Typically, the key elasticities are weaker for the older age groups. By the age of 35, most individuals have already formed separate households. Therefore, the model's treatment of the older groups is much simpler. The model distinguishes between the 35-59 age group and the 60+ group, disaggregated by gender. The model also distinguishes marital status and the presence of dependent children (not generally an issue for the 60+ group). However, there is no disaggregration by income and as a simplifying assumption all are taken to lie in the third income quartile. In fact, this is not critical to model simulations unless changes in the income distribution take place. The determination of the number of households for the older age groups can be demonstrated by looking at one group, i.e. males, aged 35-59, with a partner and dependent children. The **PopnSE** worksheet gives the total number of individuals in this group (row 257). This is simply multiplied by the probability of household formation for an individual with the same characteristics, but aged 30-34. Therefore, the probabilities for the 30-34 age group in the probit model become the reference group for the older groups. Since (in 1991), the estimated probability was 0.984, the older age groups will, generally, be less sensitive to changes in the economic variables than the younger groups.

The Housing Market

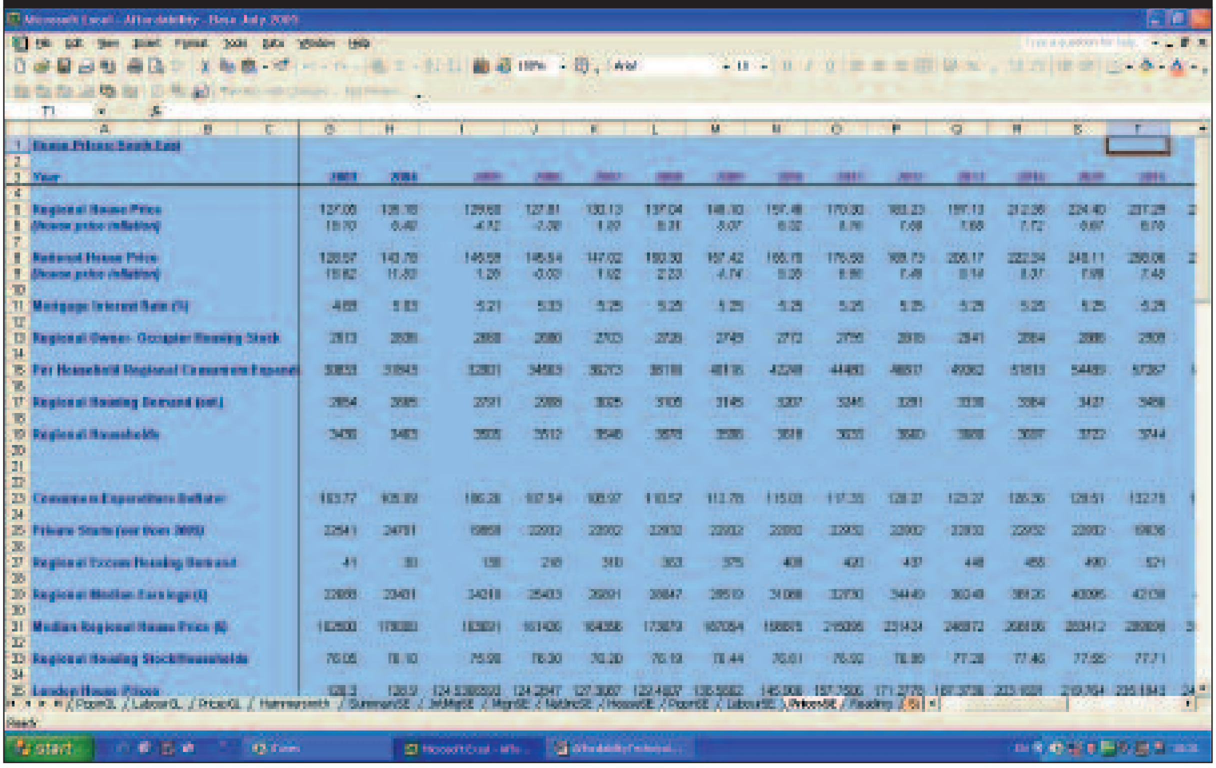
The housing market worksheet is shown in Figure 10, divided into three segments. This is another part of the model where two equation sets – for regional house prices – operate. The key row in the worksheet is row 5, which derives the average mix-adjusted house price index (ODPM measure). Although this is an average, it drives the median and lower quartile house prices that feed elsewhere in the model, including the affordability measures. Row 8 is also important, giving the national price as the weighted average of the regional indicators.

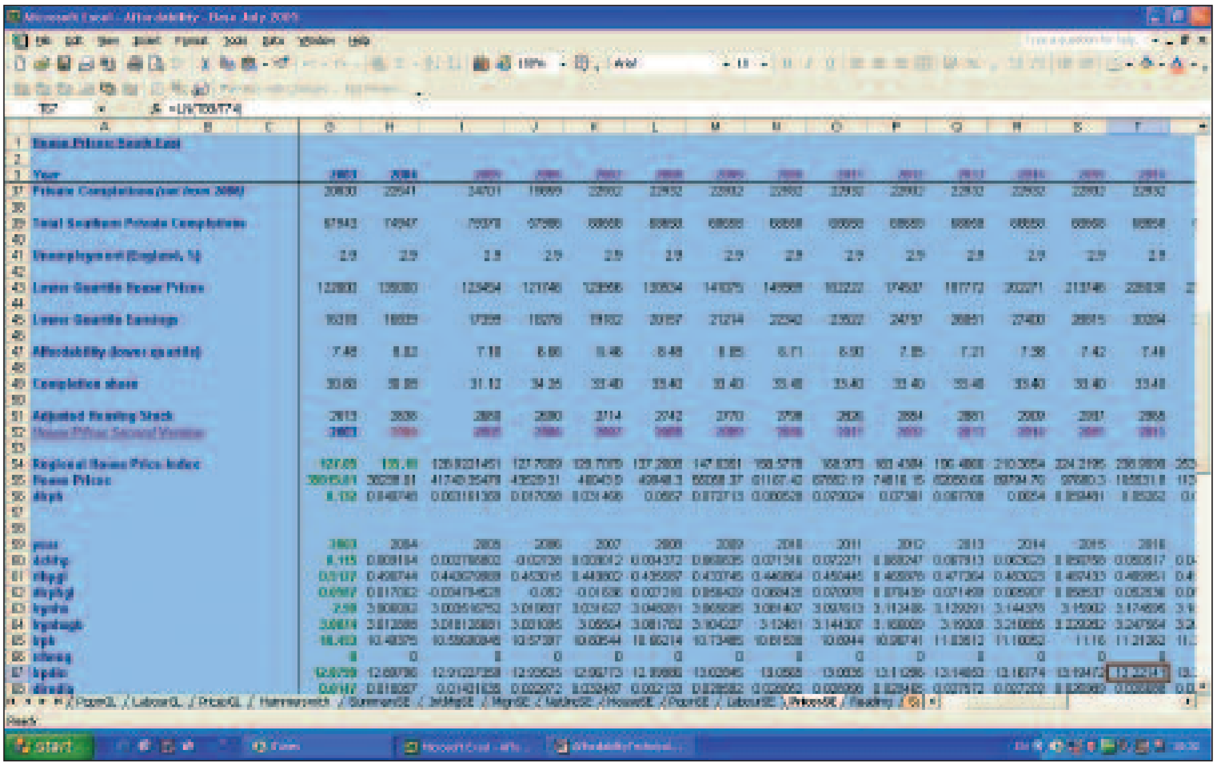
It should be noted that row 5 is set equal, by identity, to row 54, when Version 1 is used. In Version 1, the estimated (complex) equation is given in row 54. The variables that feed into the equation are given between rows 55 and 94. Row 56 is particularly important since it sets out the main behavioural equation.

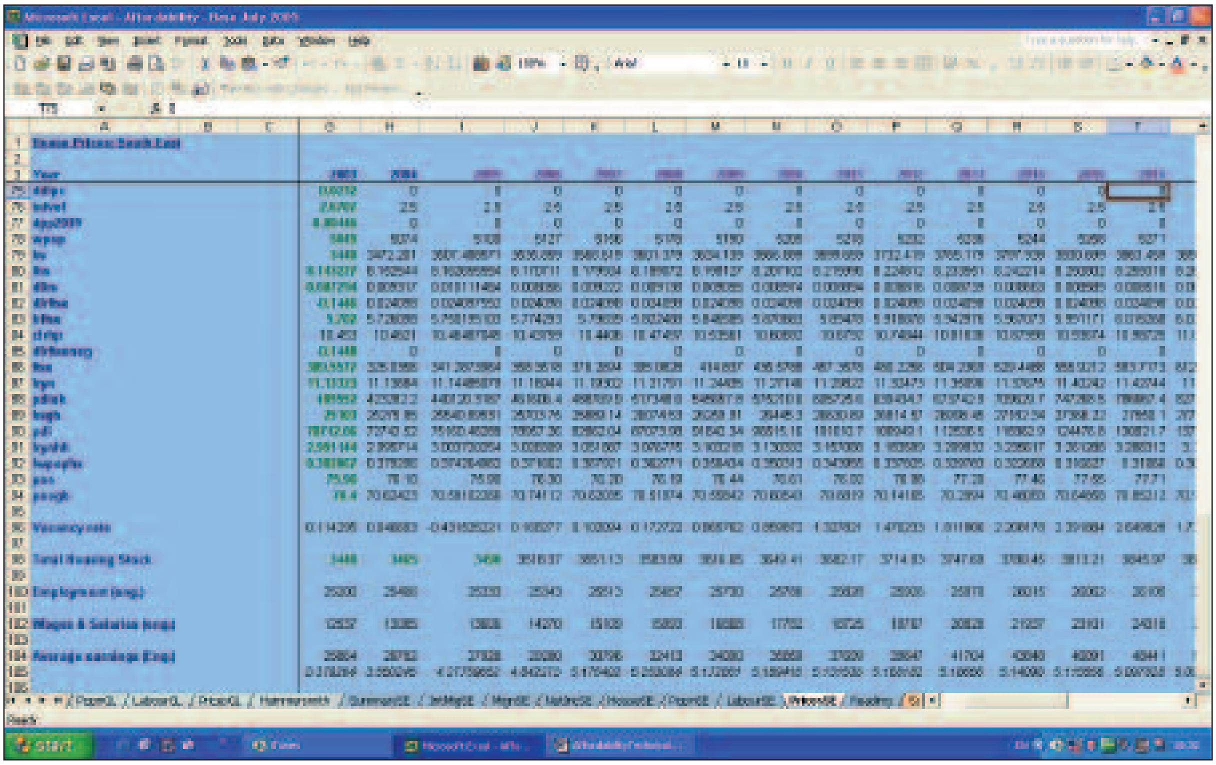
Under Version 2 of the model, row 5 has a separate equation and rows 54-94 are redundant. Although the two sets of price equations will not produce identical projections, they have approximately been brought in line with each other by residual adjustment.

As noted above, the Version 1 equation is derived between rows 54 and 94. The details of the estimated relationship are given below Figure 10. The key features of the equation are described in the Final Report. It should also be noted below that the SUR estimates included Wales (WW) and Scotland (SC), although they are not used in the model in practice.

Figure 10: **The Housing Market (HouseSE)**







Version 1 Real House Price Equations

(a) excluding London and the South

$\Delta lrhp_r$

Dependent variable = change in log real house prices in region r. House prices are mix adjusted and adjusted for changes in survey coverage.

$= b0_r$

Region specific intercept.

$+ byear_r * (year – 1990)$

Region specific linear trend.

$+ b\Delta rlhp1 * [(1 – w1_r – w2_r) * \Delta lrhp_{r,-1} + w1_r{}^* \Delta clrhp_{r,-1} + w2r * \Delta lrhp_{GL,-1}]$

Positive effect of lagged change in real house prices in the region, in contiguous regions and in Greater London. Weights are region specific.

$+ \lambda * [\gamma * ((1 – w_0) * lrynhs_r + w_0 * lrynhs_{GB}) – lrhp_{r,-1}]$

$+ brlhp_{gl,r,-1} * rlhp_{gl,-1}$

Error correction terms. λ = 0.25 = speed of adjustment. γ = 2 = long run elasticity of real (non-property personal disposable) income per house. w_0 = 0.5 used to weight regional and national income per house figures.

The first term says that, in the long run, log real house prices = 2 log real income per house generally. The second term allows house prices in the EM, WM and SW regions to be "driven" by GL prices.

$+ brrhneg1 * (rrhneg_{r,-1} + rrhneg_{r,-2} + rrh.neg_{r,-3} + rrh.neg_{r,-4})$

Negative downside risk effect using MA4 of lagged negative real rates of return on housing.

$+ b\Delta lrpdi * \Delta lrpdin$

Positive effect of changes in national non-property personal disposable income (pdi).

$+ b\Delta lrpdi_{-1} * \Delta lrpdin_{-1}$

Positive effect of lagged change in non-property income.

$+ bcci_{-1} * cci_{-1}$

Positive effect of (lagged) credit conditions. Based on cci measure.

$+ bcci\Delta lrpdi *cci * \Delta lrpdin$

Negative interaction of cci and Δlrpdin, since households are less cash constrained if cci is high so that income changes matter less.

$+ b\Delta labmr * \Delta^2 labmr$

Negative effect of (two period) change in log (tax adjusted) nominal mortgage rate.

$+ blabmr * labmr_{-1}$

Negative effect of (lagged) nominal mortgage rates.

$+ bcrabmr * ccci * rabmr$

Negative effect of real mortgage interest rates. The effect is stronger as credit becomes more freely available.

$+ b\Delta^2 lpc * \Delta^2 lpc$

Negative effect of acceleration in inflation.

$+ binfvol * infvol$

Negative inflation volatility effect.

$+ b\Delta pop2039 * \Delta pop2039_{r,-1}$

Positive demographic effect – change in regional share of working age population aged 20 to 39.

$+ b\Delta lwpop * \Delta log(wpop_r/hs_{r,-1})$

Positive effect of change in ratio of working age population to housing stock.

+ bΔlrftse * Δlrftse
Positive wealth effect of change in log real FTSE.

+ b88 * (d88 + d88(-1)) + b01 * d01
Positive year dummies for 1988, 1989 and negative for 2001.

(b) Greater London and South

The GL and ST equation is similar to the equation in (a) except that (i) some of the short run coefficients and time dummies are allowed to take different values and (ii) negative changes in the real value of the FTSE are included as an additional explanatory variable. As a result changes in the real value of the FTSE have an asymmetric effect in GL and the ST. The negative effect of a fall in the real FTSE is much smaller that the positive effect of a rise in the real FTSE.

Seemingly Unrelated Regression (SUR) Parameter Estimates

No of Observations = 32 (1972 to 2003).

Imposed Restrictions: $\lambda = 0.25$, $\gamma = 2$ and $w_0 = 0.5$.

	Parameters	Estimates	Std Errors	t-Stats
Intercept Terms	$b0_{nt}$	.816337	.045096	18.1024
	$b0_{yh}$	.821089	.045267	18.1387
	$b0_{em}$	.792370	.050729	15.6197
	$b0_{wm}$	.781535	.048485	16.1191
	$b0_{gl}$	.812433	.048004	16.9244
	$b0_{st}$	.891332	.055097	16.1776
	$b0_{sw}$	.841282	.055741	15.0926
	$b0_{ww}$	.864407	.045082	19.1740
	$b0_{sc}$	.793275	.044929	17.6562
Trend Terms	$byear_{nt}$	.003866	.000769	5.02599
	$byear_{yh}$	.004378	.000795	5.50663
	$byear_{em}$	.004159	.000808	5.14602
	$byear_{wm}$	.003204	.000712	4.50003
	$byear_{gl}$	.002067	.000970	2.13153
	$byear_{st}$	.002609	.000863	3.02271
	$byear_{sw}$	.002885	.000908	3.17860
	$byear_{ww}$	.004587	.000833	5.50902
	$byear_{sc}$	.006083	.000823	7.38773
Error Correction in Real Income per house $= 2(^1/_2 * lrynhs_r + {^1/_2} * lrynhs_{GB}) - lrhp_{r,-1}$		0.25	–	–
Relative House Prices in GL Lagged	$rlhp_{gl,-1}$ (em)	.156220	.060676	2.57467
	$rlhp_{gl,-1}$ (wm)	.119797	.053228	2.25063
	$rlhp_{gl,-1}$ (st)	.118522	.071815	1.65039
	$rlhp_{gl,-1}$ (sw)	.134407	.070340	1.91081
House Price Inflation Lagged = "Weighted" Combination of $\Delta rlhp_{r,-1}$, $\Delta crlhp_{r,-1}$ and $\Delta rlhp_{gl,-1}$		.472258	.035180	13.4239
Contiguous Region "Weights"	$w_{1,nt}$	.995513	.277380	3.58898
	$w_{1,yh}$	1.19799	.369470	3.24245
	$w_{1,em}$	.598031	.445827	1.34140
	$w_{1,wm}$	0	–	–
	$w_{1,gl}$	0	–	–
	$w_{1,st}$	.301488	.421165	.715843
	$w_{1,sw}$	–.270018	.455585	–.592683
	$w_{1,ww}$	1.61278	.391020	4.12454
	$w_{1,sc}$	0	–	–

GL "Weights"	$w_{2,nt}$	–.033676	.115422	–.291766
	$w_{2,yh}$	.027162	.125512	.216408
	$w_{2,em}$	.120642	.183529	.657344
	$w_{2,wm}$	.345958	.093789	3.68871
	$w_{2,gl}$	1	–	–
	$w_{2,st}$	1.04955	.291981	3.59460
	$w_{2,sw}$	.987380	.195607	5.04778
	$w_{2,ww}$	–.189605	.169555	–1.11825
	$w_{1,sc}$	–.171946	.109425	–1.57136
Income Growth & Credit Effects	Δlrpdi (ex. gl & st)	.739242	.084516	8.74672
	Δlrpdi (gl)	1.16840	.159653	7.31839
	Δlrpdi (st)	.815790	.137623	5.92772
	cci * Δlrpdi	–3.47553	.765540	–4.53997
	$\Delta lrpdi_{-1}$ (ex. gl & st)	.445231	.086779	5.13064
	$\Delta lrpdi_{-1}$ (gl)	.570193	.206235	2.76478
	$\Delta lrpdi_{-1}$ (st)	.415719	.182308	2.28031
	cci_{-1}	.314915	.101220	3.11118
Risk	$MA_4\ rrhne_{gr,-1}$	.162626	.026001	6.25470
Interest Rate Effects	$\Delta_2$labmr (ex. gl & st)	–.038951	.014876	–2.61847
	$\Delta_2$labmr (gl)	–.070328	.026995	–2.60516
	$\Delta_2$labmr (st)	–.064618	.023274	–2.77644
	$labmr_{-1}$	–.053603	.012118	–4.42358
	ccci * rabmr	–6.03177	1.20197	–5.01824
Inflation Effects	Δ^2lpc	–.802741	.083134	–9.65604
	inflation volatility	–.002525	.000710	–3.55683
Demog. Etc. Effects	$\Delta pop2039_{r,-1}$	2.48444	1.04108	2.38641
	$\Delta(lwpop_r\text{-}lhs_{r,-1})$	1.88623	.335154	5.62794
Change in Real FTSE Effects	ΔlrFTSE (ex. gl & st)	.046322	.014981	3.09197
	ΔlrFTSE (gl)	.314082	.068481	4.58643
	ΔlrFTSE (st)	.266578	.052137	5.11307
	ΔlrFTSE if neg (gl)	–.235943	.092366	–2.55445
	ΔlrFTSE if neg (st)	–.224680	.067804	–3.31365
Time Dummies	'88 & '89 (ex. gl & st)	.108594	.009064	11.9799
	'01 (ex. gl & st)	–.067621	.010596	–6.38187
	'88 (gl)	.064481	.026011	2.47898
	'01 (gl)	–.117934	.026246	–4.49338
	'88 & '89 (st)	.155632	.020773	7.49210
	'01 (st)	–.072784	.021099	3.44960

Some Single Equation Diagnostics

Equation: **North**
Dependent variable: $\Delta LRHP_{NT}$

Mean of dep. var. = .032394
Std. error of regression = .024673
R-squared = .911974
LM het. test = .906105 [.341]
Durbin-Watson = 2.14185

Equation: **Yorkshire and Humberside**
Dependent variable: $\Delta LRHP_{YH}$

Mean of dep. var. = .036278
Std. error of regression = .027777
R-squared = .900464
LM het. test = 3.17893 [.075]
Durbin-Watson = 2.16284

Equation: **East Midlands**
Dependent variable: $\Delta LRHP_{EM}$
Mean of dep. var. = .040281
Std. error of regression = .024824
R-squared = .946347
LM het. test = .659999 [.417]
Durbin-Watson = 1.53035

Equation: **West Midlands**
Dependent variable: $\Delta LRHP_{WM}$
Mean of dep. var. = .036469
Std. error of regression = .017096
R-squared = .971234
LM het. test = 1.18162 [.277]
Durbin-Watson = 2.01538

Equation: **Greater London**
Dependent variable: $\Delta LRHP_{GL}$
Mean of dep. var. = .041177
Std. error of regression = .028686
R-squared = .938605
LM het. test = 14.2160 [.000]
Durbin-Watson = 2.34873

Equation: **South**
Dependent variable: $\Delta LRHP_{ST}$
Mean of dep. var. = .039577
Std. error of regression = .023016
R-squared = .962070
LM het. test = .499659 [.480]
Durbin-Watson = 1.41143

Equation: **South West**
Dependent variable: $\Delta LRHP_{SW}$
Mean of dep. var. = .040064
Std. error of regression = .027368
R-squared = .948474
LM het. test = 3.50900 [.061]
Durbin-Watson = 1.76924

Data Construction and Sources

Since the data construction in this module is complex, the data are described in some detail. Many of these variables are also used in the labour market module.

(i) All regional and national log house price indices, which are derived by linking published ODPM mixed adjusted second hand house price indices, are adjusted by adding 0.8 * lhpadj2, which corrects for composition changes as banks etc entered the mortgage market. All indices have been rebased to 1985 average second hand house price values.

(ii) Non-property personal disposable income (pdi) rlrynr = log real non-property pdi in region r:
$rlryn_r = lrpdin + (1/3*rlfte_{r,+1} + 2/3*rlfte_r) + rlempr_r + rlwpop_r + rltaxadj_r + \log((1-spt_r) + rept_r * spt_r$
where:
lrpdin = log real non-property pdi in UK.
non-property pdi = (1 – tuk) * (wage and salaries qwlt + mixed income qwlw);
tuk = 1 – (post tax pdi/pre tax pi). Sources – qwlt,qwlm = Blue Book, tuk = OEF regional model data.

$rlfte^r$ = log relative total full earnings in April in region r (relative to GB). 1/3 * one period lead + 2/3 * current value because April data used. Source: NES linked to ASHE.
$rlempr_r$ = log relative employment rate in region r. Source: OEF regional model data.
$rlwpop_r$ = log relative working age population in region r. Source: OEF regional model data;
$rltaxadj_r$ = log relative (post tax pdi/pre tax pi) in region r. Source: OEF regional model data.
spt_r = share of part time employment in total employment in region r. Source: ONS.
$rept_r$ = ratio of average part time to full time earning in region r. Source: NES, assumed unchanged post 2001 and pre 1975.

(iii) Log Income per house variable $lrynhs_r = rlryn_r - \log(hs_{r,-1}) - 0.7*\log(poo_{r,-1})$ where hs_r = housing stock in region r and poor = proportion of owner occupiers in region r.

(iv) Return on housing in region r $rrh_r = \Delta lhp_{r,-1} + 0.03 - abmr$ and $rrhneg_r = rrh_r$ * 1(rrhr<0) where Δlhp. = first difference of log house price index in region r (source: linked ODPM data), abmr = tax adjusted building society mortgage rate bmr with the adjustment based on basic rate of tax (source: OEF data) and $1(rrh_r < 0) = 1$ if rrh_r is negative and 0 otherwise.

(v) Contiguous house price changes. Δclrhp. = log change in real house prices regions contiguous to region r. The weights used are based on full time wage bills.

(vi) Other variables.
cci = index of credit conditions from Fernandez-Corugedo and Muellbauer (2004)
lpc = log consumer expenditure deflator. Source: Blue Book
rabmr = abmr – Δlpc is the real mortgage rate.
$pop2039_r$ = (population aged 20 to 39)/(population aged 20 to 69) in region r.
infvol = MA_4 of lagged absolute value of $\Delta_4 lpc - \Delta_4 lpc_{-4}$ based on quarterly data; then annualised.
ΔlrFTSE = change in log (FTSE/pc) i.e. real FTSE index.
ΔlrFTSEneg = ΔlrFTSE if negative and zero otherwise. It is a proxy for downside risk in the stock market.
D88 = dummy for mix of 1988 effects (poll tax and Lawson proposal to end multiple tax relief on Aug 1st 1988)
D01 = dummy for 9/11 and/or stock market turmoil in 2001.

House Price Expectations

Measures of house price expectations feed into the labour market model (**LabourSE**, row 27), but it is convenient to set them out here since they are based on the above house price equation. However, not all the variables from the full price equations above are included. Particularly noticeable is the fact that they do not include supply side variables in terms of the housing stock or new construction. In these 'naïve' relative house price growth forecasting equations, the dependent variable is one year ahead log change in ith region house price minus GB house price.

Equation for all regions excluding London and the South East

Drlhp1. = a1. +a0.*(year – 1990)
Fixed effect and region specific trend

+ b1 * ((1 – wdclrhp1_. – wdlrhpgl1_.) * drlhp. + wdclrhp1_. * dcrlhp. + wdlrhpgl1_. * drlhpgl)

Persistence effect is a weighted average of own region, contiguous region and GL relative house price change, where weights differ by region to capture different degree of 'ripple' effect. Typically the GL change has a bigger coefficient for regions closer to London.

– a4*rlhp. +a4*rlfte.$_{(-1)}$

Equilibrium correction term, imposing coefficient of 1 in long-run solution on the relative earnings effect. Speed of adjustment, a4 is around 0.35.

+ a7*crlhp.

Contiguous region relative to GB house price effect.

+ a10*[(rrh.neg)-(rrhgbneg)
+ (rrh.neg$_{(-1)}$)-(rrhgbneg$_{(-1)}$)
+ (rrh.neg$_{(-2)}$)-(rrhgbneg$_{(-2)}$)
+ (rrh.neg$_{(-3)}$)-(rrhgbneg$_{(-3)}$)]/4

Downside risk effect for region I relative to GB.

+ b2*(labmr- labmr$_{(-2)}$)*rlpoo.$_{(-1)}$

Two year change in log mortgage interest rate has negative effect in regions with high relative owner occupation rates.

+ a3*labmr*rlpoo.$_{(-1)}$

Similar effect for log level of mortgage interest rate.

+ b3 * dlrftseneg + b4* dlrftse;

With b3 close to minus b4, upturns in real FTSE index lower relative house prices outside London and the South East. When the real FTSE index falls, there is no effect on relative house prices. Note b3gl and b4gl have the opposite signs of b3 and b4, indicating the opposite happens in London. For the South East, b3st and b4st have the same sign as London, but are much weaker, indicating that the South East is in a more intermediary position regarding these stock market effects. Interestingly, similar effects show up in the structural real house price equations and in the earnings, employment and unemployment equations

Equation for South East

Δrlhp1st = a1st +a0st*(YEAR – 1990)
+ b1 * ((1 – wdclrhp1_st – wdlrhpgl1_st) * drlhpst
+ wdclrhp1_st * dcrlhpst
+ wdlrhpgl1_st * drlhpgl)
- a4*rlhpst +a4*rlftest$_{(-1)}$
+ a5*(rlftegl$_{(-1)}$-rlftest$_{(-1)}$)
+ a7*crlhpst
+ a10st*[(rrhstneg)-(rrhgbneg)
+ (rrhstneg$_{(-1)}$)-(rrhgbneg$_{(-1)}$)
+ (rrhstneg$_{(-2)}$)-(rrhgbneg$_{(-2)}$)
+ (rrhstneg$_{(-3)}$)-(rrhgbneg$_{(-3)}$)]/4
+ b2*(labmr- labmr(-2))*rlpoost$_{(-1)}$
+ a3*labmr*rlpoost(-1)?+a33*cci*rlpoost$_{(-1)}$
+ b3st * dlrftseneg
+ b4st* dlrftse;

Equation for Greater London

Δrlhp1gl = a1gl+a0gl*(YEAR-1990)
+ b1 * ((1 – wdclrhp1_gl) * drlhpgl + wdclrhp1_gl * dcrlhpst)
-a4*rlhpgl + a4*rlftegl$_{(-1)}$
+ a7*crlhpgl
+ a10gl*[(rrhglneg)-(rrhgbneg)
+ (rrhglneg$_{(-1)}$)-(rrhgbneg$_{(-1)}$)
+ (rrhglneg$_{(-2)}$)-(rrhgbneg$_{(-2)}$)
+ (rrhglneg$_{(-3)}$)-(rrhgbneg$_{(-3)}$)]/4
+ b2gl*(labmr- labmr$_{(-2)}$)*rlpoogl$_{(-1)}$
+ a3gl*labmr*rlpoogl$_{(-1)}$
+ b3gl * dlrftseneg
+ b4gl* dlrftse;

Parameter	Estimate	Standard Error	t-statistic	P-value
A1NT	–.056327	.013028	–4.32338	[.000]
A0NT	–.503341E-04	.592210E-03	–.084994	[.932]
B1	.403562	.125265	3.22168	[.001]
WDCLRHP1_NT	.927824	.358993	2.58451	[.010]
WDLRHPGL1_NT	–.526716	.307369	–1.71363	[.087]
A4	.341260	.038905	8.77162	[.000]
A7	.096058	.056135	1.71118	[.087]
A10	.747753	.191128	3.91231	[.000]
B2	–.087170	.050378	–1.73032	[.084]
A3	–.120220	.051212	–2.34750	[.019]
B3	.106631	.035380	3.01385	[.003]
B4	–.089171	.029536	–3.01908	[.003]
A1YH	–.028826	.016178	–1.78184	[.075]
A0YH	.129527E-02	.708118E-03	1.82917	[.067]
WDCLRHP1_YH	1.78177	.671437	2.65366	[.008]
WDLRHPGL1_YH	–.564402	.354198	–1.59346	[.111]
A1WM	–.041782	.658448E-02	–6.34550	[.000]
A0WM	.623373E-03	.431295E-03	1.44535	[.148]
WDCLRHP1_WM	.023806	.522032	.045603	[.964]
WDLRHPGL1_WM	–.243154	.239966	–1.01328	[.311]
A1EM	–.037465	.832485E-02	–4.50043	[.000]
A0EM	.111185E-02	.456282E-03	2.43676	[.015]
WDCLRHP1_EM	1.91673	.643461	2.97878	[.003]
WDLRHPGL1_EM	–.944011	.418875	–2.25368	[.024]
A1SW	–.018325	.016246	–1.12798	[.259]
A0SW	.936222E-03	.611858E-03	1.53013	[.126]
WDCLRHP1_SW	.643135	.465799	1.38072	[.167]
WDLRHPGL1_SW	.370504	.230999	1.60392	[.109]
A1WW	–.054697	.014878	–3.67632	[.000]
A0WW	.234334E-02	.666972E-03	3.51340	[.000]
WDCLRHP1_WW	2.51736	.717562	3.50822	[.000]
WDLRHPGL1_WW	–.965790	.441036	–2.18982	[.029]
A1SC	.078366	.040994	1.91166	[.056]
A0SC	–.799142E-02	.243858E-02	–3.27707	[.001]
WDCLRHP1_SC	.248110	.260228	.953431	[.340]
WDLRHPGL1_SC	–.461879	.282740	–1.63358	[.102]
A1ST	.120564	.038299	3.14796	[.002]
A0ST	.150397E-02	.107620E-02	1.39748	[.162]
WDCLRHP1_ST	–.826994	.931757	–.887564	[.375]
WDLRHPGL1_ST	.790530	.634497	1.24592	[.213]
A10ST	.670600	.175350	3.82435	[.000]
B3ST	–.059053	.036058	–1.63773	[.101]
B4ST	.070876	.031548	2.24657	[.025]
A5	–.327686	.192152	–1.70535	[.088]
A1GL	.537601E-02	.033896	.158601	[.874]
A0GL	–.946809E-03	.915713E-03	–1.03396	[.301]
WDCLRHP1_GL	–.605384	1.08566	–.557621	[.577]
A10GL	–.137004	.421638	–.324934	[.745]
B2GL	–.252143	.155875	–1.61760	[.106]
A3GL	.110858	.069674	1.59108	[.112]
B3GL	–.221792	.075422	–2.94067	[.003]
B4GL	.230240	.062783	3.66727	[.000]

Equation: **North**
Dependent variable: ΔRLHP1
Mean of dep. var. = -.403374E-02
Std. error of regression = .027285
R-squared = .720670
LM het. test = 2.57655 [.108]
Durbin-Watson = 2.15582

Equation: **Yorkshire and Humberside**
Dependent variable: ΔRLHP1
Mean of dep. var. = -.225989E-03
Std. error of regression = .032960
R-squared = .594236
LM het. test = .563726 [.453]
Durbin-Watson = 2.05233

Equation: **West Midlands**
Dependent variable: ΔRLHP1
Mean of dep. var. = -.131385E-02
Std. error of regression = .019290
R-squared = .541601
LM het. test = .422303 [.516]
Durbin-Watson = 1.82508

Equation: **East Midlands**
Dependent variable: DRLHP1
Mean of dep. var. = .145222E-02
Std. error of regression = .019939
R-squared = .608175
LM het. test = 2.66447 [.103]
Durbin-Watson = 2.05612

Equation: **South West**
Dependent variable: ΔRLHP1
Mean of dep. var. = -.348186E-03
Std. error of regression = .019037
R-squared = .524254
LM het. test = .081709 [.775]
Durbin-Watson = 1.72499

Equation: **South**
Dependent variable: ΔRLHP1
Mean of dep. var. = .875123E-03
Std. error of regression = .014085
R-squared = .759384
LM het. test = .925434 [.336]
Durbin-Watson = 1.76096

Equation: **Greater London**
Dependent variable: DRLHP1
Mean of dep. var. = .333754E-02
Std. error of regression = .025442
R-squared = .664219
LM het. test = .147394 [.701]
Durbin-Watson = 2.14404

Version 2 Real House Price Equations

Once again the price equations in Version 2 are much simpler. The main variables affecting real prices (in the South of England) are the (log) ratio of the number of owner-occupied dwellings relative to the number of households; per household regional consumers' expenditure – which proxies permanent income; interest rates; a dummy variable for abolition of double mortgage tax relief in 1988. Typically, both change and levels terms appear in the models, which are estimated as error correction equations. SUR is used, in order to capture spatial error correlation.

The equations draw on earlier work by Meen (1999), which finds that England can be divided into 3 meta-regions – South, North and Midlands. Therefore, the coefficients typically vary across the meta regions, but only to a limited extent within them. A second important distinction is that the southern regions do not include spatial contiguity terms (although the errors are spatially correlated). The similar movements in prices over time occur primarily because of the coefficient equality. This issue is discussed in Meen (1999). But the Midlands and Northern regions include spatial contiguity through a conditioning on prices in the South East. This generates a form of ripple effect. A third issue is that house price models estimated on data post 1990 often find a major fall in the interest rate (and to a lesser extent the housing stock) elasticity), (see Meen and Andrew 1998). This is because the cut in interest rates in the early nineties was not matched by a recovery in the housing market. Meen and Andrew argue that the fall in the elasticity is a form of omitted variable bias and that once *national* models take into account factors such as changing income distributions, the elasticity rises again. However, it is not possible to include these additional factors in the regional model and we, indeed, found a fall in the interest rate and housing stock elasticities. To overcome this, we have imposed a limited number of the interest rate and housing stock elasticities in line in line with previous work and expectations from theory. Finally, London proved to be difficult to model and we have imposed coefficients in line with those for the rest of the South. This ensures that price trends in London will be similar to those in the rest of the South, which has occurred historically. The prediction errors for each equation are graphed below the table of coefficients.

The equations can be solved for the implicit long-run demand functions. These are set out below the residual graphs. The key parameters are the income and price elasticities of housing demand. In the South, the values are 0.87 and -0.34 respectively. i.e. these are slightly lower than those in the more complex Version 1 equations, but are still within the bounds indicated by micro studies of housing demand. The elasticity with respect to household formation is unity. The elasticities in the Midlands and the North cannot be compared in the same way since they are conditioned on prices in the South East. The elasticities with respect to relative regional prices are approximately one, indicating a fairly high degree of substitution across regional boundaries. It should be remembered that these are not conventional price elasticities of demand, but also represent the demand for location. The responsiveness to prices in the South East is also likely to reflect the influence of "equity transfer" for moving households, i.e. households who move from the South East will be able to transfer higher levels of equity into their new homes at times of high prices.

Overall, these equations are clearly much simpler than the Version 1 set and, as expected, the equation standard errors are higher. Nevertheless, with the exception of London, there are relatively few signs of misspecification and the key elasticities are in line with priors.

System: **UNTITLED**
Estimation Method: Seemingly Unrelated Regression
Date: 07/26/05 Time: 10:10
Sample: 1976 2003
Included observations: 28
Total system (balanced) observations 196

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.239138	0.037019	-6.459873	0.0000
C(2)	0.305478	0.056493	5.407375	0.0000
C(3)	0.050528	0.007685	6.575266	0.0000
C(4)	-0.219569	0.069076	-3.178657	0.0017
C(6)	0.570667	0.110417	5.168305	0.0000
C(7)	0.104057	0.022221	4.682877	0.0000
C(8)	-0.246927	0.037037	-6.667070	0.0000
C(9)	-0.009566	0.001735	-5.512106	0.0000
C(10)	-0.071672	0.020319	-3.527302	0.0005
C(11)	-0.256621	0.038497	-6.665988	0.0000
C(12)	-0.250441	0.037560	-6.667737	0.0000
C(13)	-2.492342	0.365372	-6.821381	0.0000
C(16)	0.308758	0.072938	4.233143	0.0000
C(17)	0.648863	0.102489	6.331072	0.0000
C(19)	-0.252502	0.053716	-4.700689	0.0000
C(20)	0.360924	0.146944	2.456207	0.0150
C(21)	0.171416	0.038604	4.440353	0.0000
C(22)	-0.006280	0.001932	-3.250592	0.0014
C(14)	-2.374307	0.345446	-6.873168	0.0000
C(15)	-2.687789	0.014343	-187.3879	0.0000
C(23)	0.118099	0.066534	1.775032	0.0776

Determinant residual covariance 1.59E-22

Equation: DLNRPHEM= C(1)+C(2)*DLNRPHEM(-1)+C(3)*LRCEHHEM(–1)+C(4)*LHSHHEM(-1)+C(6)*DLRCEHHEM+C(7)*DUM88+C(8)*LNPHEMSE(-1)+C(9)*MORT_RATE(-1)+C(10)*DUM90
Observations: 28

R-squared	0.824198	Mean dependent var	0.035350
Adjusted R-squared	0.750177	S.D. dependent var	0.088877
S.E. of regression	0.044423	Sum squared resid	0.037495
Durbin-Watson stat	2.093986		

Equation: DLNRPHWM= C(8)+C(2)*DLNRPHWM(-1)+C(3) *LRCEHHWM(-1)+C(4)*LHSHHWM (-1)+C(6)*DLRCEHHWM+C(7) *DUM88+C(8)*LNPHWMSE(-1)+C(9)*MORT_RATE(-1)+C(10) *DUM90
Observations: 28

R-squared	0.852708	Mean dependent var	0.033564
Adjusted R-squared	0.801156	S.D. dependent var	0.088070
S.E. of regression	0.039272	Sum squared resid	0.030846
Durbin-Watson stat	2.247236		

Equation: DLNRPHYH= C(11)+C(2)*DLNRPHYH(-1)+C(3)*LRCEHHYH(-1)+C(4)*LHSHHYH (-1)+C(6)*DLRCEHHYH+C(8)*LNPHYHSE(-1) +C(9)*MORT_RATE(-1)
Observations: 28

R-squared	0.607793	Mean dependent var	0.031778
Adjusted R-squared	0.495734	S.D. dependent var	0.078022
S.E. of regression	0.055405	Sum squared resid	0.064464
Durbin-Watson stat	2.574600		

Equation: DLNRPHN= C(12)+C(2)*DLNRPHN(-1)+C(3)*LRCEHHN(-1) +C(4)*LHSHHN (-1)+C(6)*DLRCEHHN+C(8)*LNPHNSE(-1)+C(9) *MORT_RATE(-1)
Observations: 28

R-squared	0.740075	Mean dependent var	0.029636
Adjusted R-squared	0.665810	S.D. dependent var	0.070985
S.E. of regression	0.041036	Sum squared resid	0.035363
Durbin-Watson stat	2.068277		

Equation: DLNRPHSE= C(13)+C(16)*DLNRPHSE(-1)+C(17) *LRCEHHSE(-1)-0.75*LHSHHSE (-1)+C(19)*LNRPHSE(-1)+C(20) *DLRCEHHSE+C(21)*DUM88+C(22)*MORT_RATE(-1)
Observations: 28

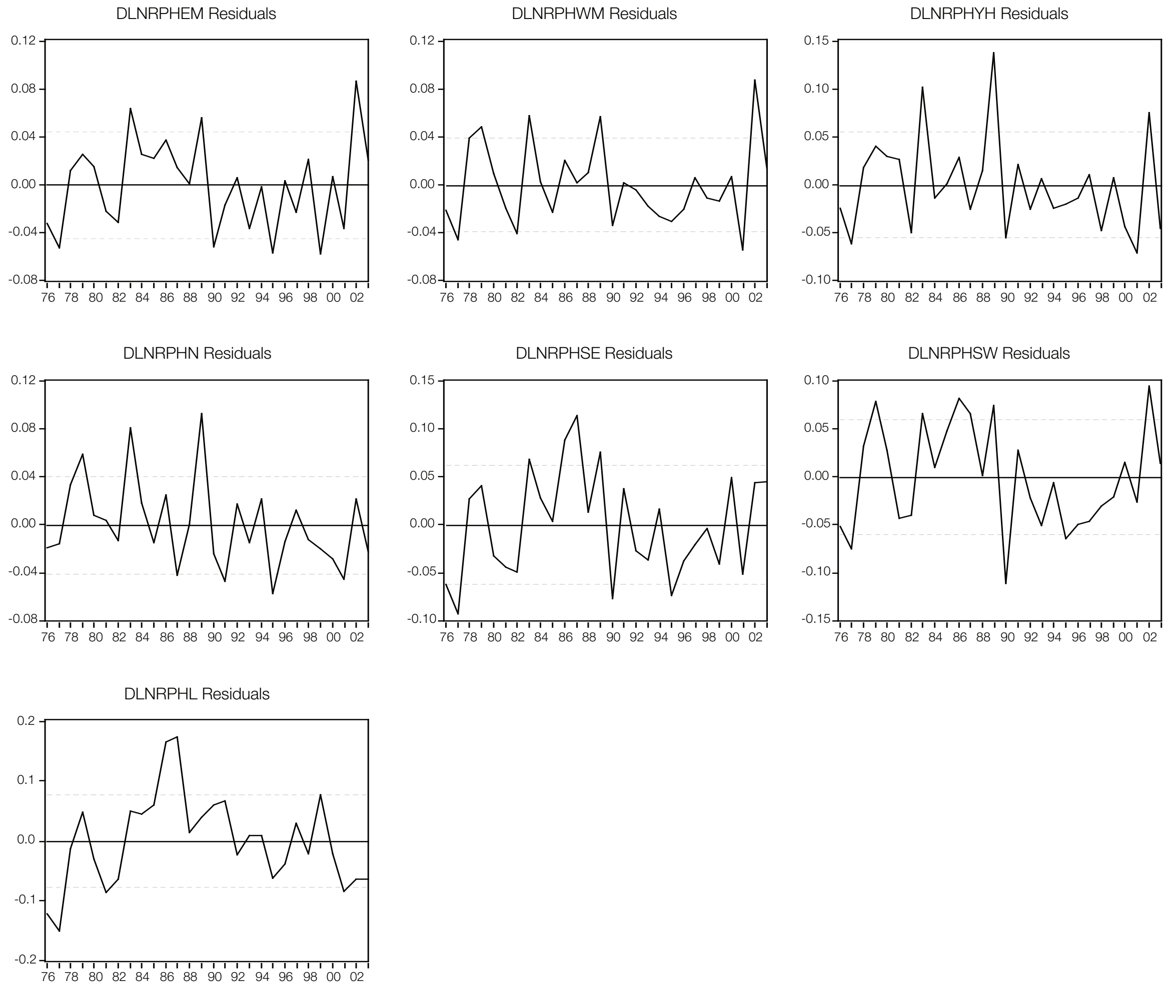
R-squared	0.715901	Mean dependent var	0.037850
Adjusted R-squared	0.634729	S.D. dependent var	0.102349
S.E. of regression	0.061857	Sum squared resid	0.080352
Durbin-Watson stat	1.764613		

Equation: DLNRPHSW= C(14)+C(16)*DLNRPHSW(-1)+C(17) *LRCEHHSW(-1)-0.75*LHSHHSW (-1)+C(19)*LNRPHSW(-1) +C(20)*DLRCEHHSW+C(21)*DUM88-0.009*MORT_RATE(-1)
Observations: 28

R-squared	0.714002	Mean dependent var	0.037493
Adjusted R-squared	0.649002	S.D. dependent var	0.101707
S.E. of regression	0.060257	Sum squared resid	0.079879
Durbin-Watson stat	1.706549		

Equation: DLNRPHL= C(15)+0.305*DLNRPHL(-1)+0.643*LRCEHHL(-1) -0.750*LHSHHGL(-1)-0.250*LNRPHL(-1)+0.351*DLRCEHHL +C(23)*DUM88-0.009*MORT_RATE(-1)
Observations: 28

R-squared	0.399852	Mean dependent var	0.041421
Adjusted R-squared	0.376769	S.D. dependent var	0.098458
S.E. of regression	0.077728	Sum squared resid	0.157081
Durbin-Watson stat	0.828195		



In the Table above, the variables are defined as:

$LRCEHH_i$	=	log real per household regional consumers expenditure
LHSHHi	=	log ratio of the owner-occupier housing stock to the number of households
LNRPHi	=	log real house prices
MORT_Rate	=	mortgage interest rate

(D) as the first letter of the mnemonic denotes the first difference

Implicit Long-Run Housing Demand Functions

South East and East

$$\ln(H^d) = \alpha_i + 1.0\ln(HH) - 0.338\ln(ph/ph_{se}) + 0.865\ln(RC/HH) - 0.0084(mrate)$$

South West

$$\ln(H^d) = \alpha_i + 1.0\ln(HH) - 0.338\ln(ph/ph_{se}) + 0.865\ln(RC/HH) - 0.0121(mrate)$$

Greater London

$$\ln(H^d) = \alpha_i + 1.0\ln(HH) - 0.333\ln(ph/ph_{se}) + 0.857\ln(RC/HH) - 0.0120(mrate)$$

Midlands and North

$$\ln(H^d) = \alpha_i + 1.0\ln(HH) - 1.127\ln(ph/ph_{se}) + 0.228\ln(RC/HH) - 0.0439(mrate)$$

The intercepts are regional varying and the variables are:

DUM88, Dum90	=	dummy variables
H^d	=	long-run owner–occupier housing demand
HH	=	number of households
mrate	=	mortgage interest rate
ph	=	ODPM index of mix-adjusted house prices
RC/HH	=	per household, real regional consumers' expenditure
rph	=	real house prices (ph/PC)
PC	=	consumers' expenditure deflator (national)

The Labour Market

The labour market module contains the key equations for employment, unemployment and average earnings (plus house price expectations discussed in the last section). In this case, there is only one version of the equation set[5]. A further important point is that each of these regional variables is expressed relative to the GB average. The national values are taken from exogenous projections and, therefore, do not vary with changes in housing market outcomes. Housing affects relative labour market performance rather than the national totals or averages.

Many of the variables that affect the labour market are the same as those used in Version 1 of the house price model. Overall, this can be seen as a joint reduced form housing and labour market model. However, the labour market model is complex and many of the rows of the worksheet are not immediately intuitive. The key employment equation is given in row 32, earnings in row 25 and unemployment in row 84 of Figure 11. All the rows between 23 and 87 are working variables that feed into these three equations or are designed to convert the regional deviations to regional averages, which are the true variables of interest. The row names relate to the equations set out below Figure 11.

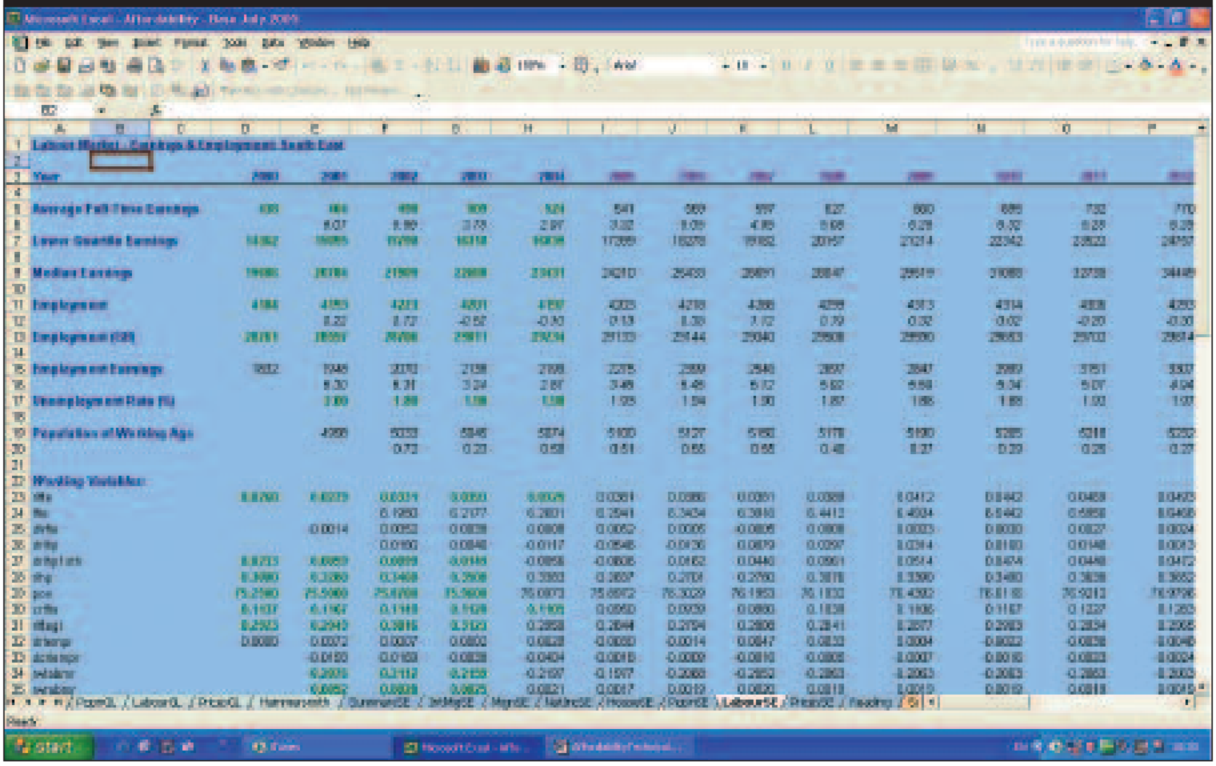
Three points should be noted. First, the key earnings equation is for *average* earnings. Median and lower quartile earnings grow at the same rate. Therefore a fundamental assumption of the model is that the earnings distribution does not change over the projection period.

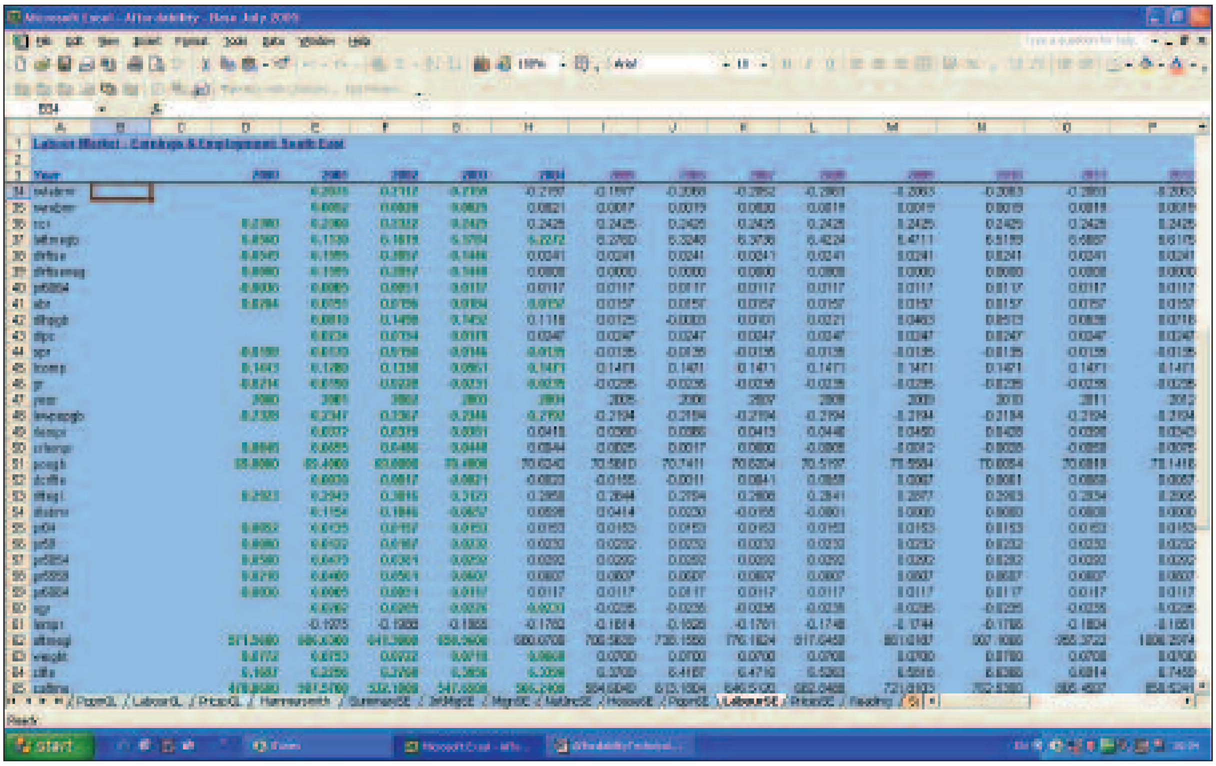
Second, the labour market equations typically include time trends. Although there can be good reasons for their inclusion in estimation, they can be problematic in projection; although the dependent variables are specified as regional shares, the trends can mean that, over very long time periods, the shares can become greater than one or negative. In some cases, therefore, in the base scenarios, the trends have been attenuated.

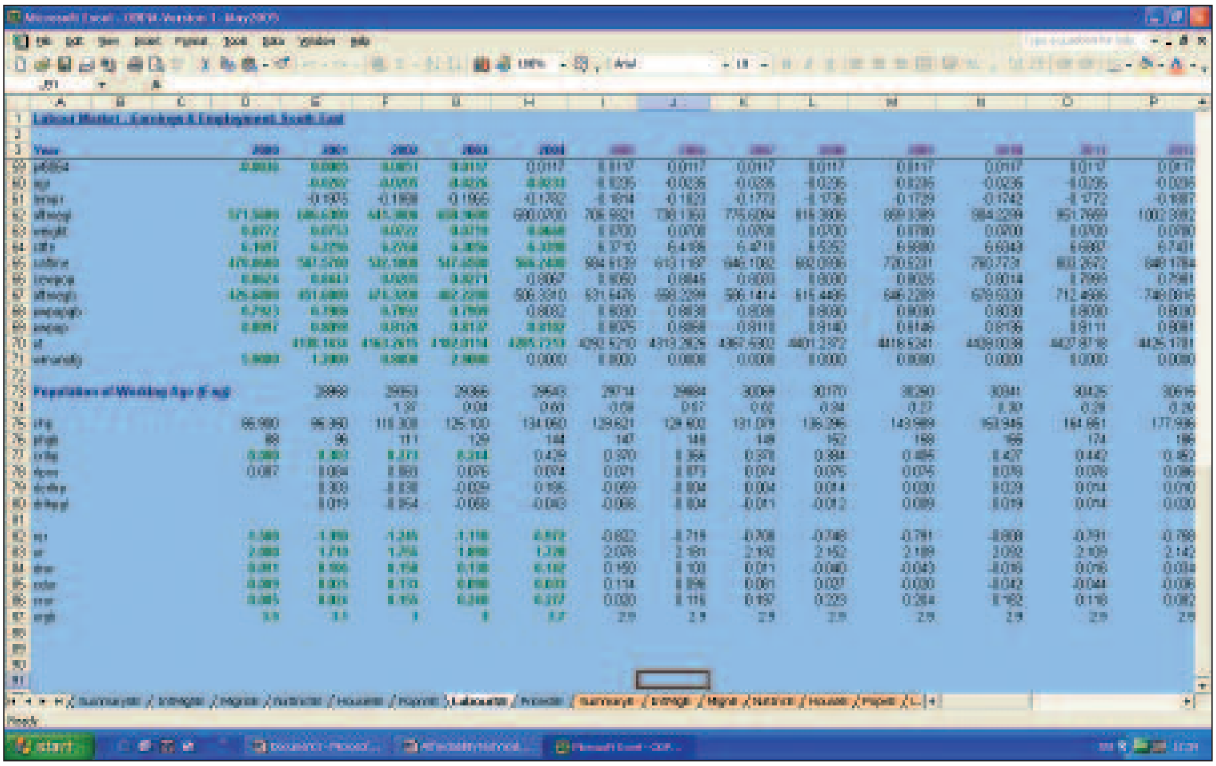
Third, spatial contiguity effects are again extensive. However the aggregations of the South East with the East (South) and the North West with the North East (North) in estimation causes problems for model construction. As in the price equations, the need to disaggregate the regions again means that the spatial weights matrices are not identical to those used in estimation.

5 With the exception of unemployment.

Figure 11: The Labour Market (LabourSE)







Average Earnings

The dependent variable is the change in the deviation from GB of the ith region log full time average earnings. Data are taken from the Annual Survey of Hours and Earnings (ASHE) and the earlier New Earnings Survey (NES).

(i) All Regions Excluding London and the South

drlfte. = a0.

+ b12 *drlhp1.h

'naïve' forecast of relative house price change. Has negative coefficient consistent with user cost interpretation. Lower user cost for workers results in lower wage demands (or ability for firms to hire more cheaply than otherwise)

- a1 * rlfte.(-1)

Error correction term.

+ a1 * a14* rlhp.(-1)*poo.(-1)

positive relative house price effect.

+ b4 * ((1 – c1) * drlempr.(-1) + c1 * dcrlempr.(-1))

employment rate dynamics. Growth in employment rate both in region and contiguous region tends to raise wages. Note that level and change in relative unemployment rates is not significant.

+ a1 * a6 * (rwlabmr.(-1)+rwlabmr.(-2))/2

log tax adjusted mortgage rate weighted by owner occupation rate in region minus GB has marginal negative effect, possibly via labour demand.

+ b8 * dlrftse(-1) + b9*dlrftseneg(-1)

these two rates of growth of the real FTSE index work similarly here as they do in the employment rate equation and in the house price equation. They suggest that declines in the real FTSE are largely neutral, but rises lower relative earnings in the non-GL regions and raise them in GL. As for employment rates, the South East is roughly neutral in an intermediate position between GL and the rest of the country.

+ a50*(pr5054.(-1))+a55*(pr5559.(-1)) + a60*(pr6064.(-1))

high proportions of working age pop in the 50-60 age group raise relative earnings, but a high proportion in the 60-64 group, lowers relative earnings, probably reflecting the hump shaped age-earnings profile.

+ a1*a151 * abr.(-1) + a1*a153*abr.(-1)*(dlhpgb(-1)-dlpc(-1))

a high proportion of employment in banking raises relative earnings and a house price boom enhances the effect.

+ a1*a161 * apr.(-1) + a1*a162 * apr.(-1) *lcomp(-1) + a1*a162 *apr.(-1) *lcomp(-2)

like the competitiveness effect on employment rates, this has a clear demand side interpretation.

+ a1*a171 * gr.(-1)

A high proportion of government employment tends to raise relative earnings, probably because of national bargaining in the public sector.

+ a20.*(YEAR-1990);

region specific time trends.

(ii) London

drlftegl = a0gl
+ b12 *drlhp1glh
- a1 * rlftegl(-1)
+ a1 * a14* rlhpgl(-1)*poogl(-1)
+ b4 * ((1 – c1) * drlemprgl(-1) + c1 * dcrlemprgl(-1))
+ a1 * a6 * (rwlabmrgl(-1)+rwlabmrgl(-2))/2
+ b8gl * dlrftse(-1)
+ b9gl*dlrftseneg(-1)
+ a50*(pr5054gl(-1))+a55*(pr5559gl(-1))
+ a60*(pr6064gl(-1))
+ a1*a151 * abrgl(-1) + a1*a153*abrgl(-1)*(dlhpgb(-1)-dlpc(-1))
+ a1*a161 * aprgl(-1)
+ a1*a162 * aprgl(-1) *lcomp(-1) + a1*a162 *aprgl(-1) *lcomp(-2)
+ a1*a171 * grgl(-1)
+ a20gl*(YEAR-1990);

(iii) South

drlftest = a0st
+ b12 *drlhp1sth
- a1 * rlftest(-1)
+ a1 * a14* rlhpst(-1)*poost(-1)
+ b4 * ((1 – c1) * drlemprst(-1) + c1 * dcrlemprst(-1))
+ a1 * a6 * (rwlabmrst(-1)+ rwlabmrst(-2))/2
+ b8st * dlrftse(-1)
+b9st*dlrftseneg(-1)
+a50*(pr5054st(-1))+a55*(pr5559st(-1))
+a60*(pr6064st(-1))
+ a1*a151 * abrst(-1) + a1*a153*abrst(-1)*(dlhpgb(-1)-dlpc(-1))
+ a1*a161 * aprst(-1)
+ a1*a162 * aprst(-1) *lcomp(-1) + a1*a162* aprst(-1) *lcomp(-2)
+ a1*a171 * grst(-1)
+ a20st*(YEAR-1990);

Parameter	Estimate	Standard Error	t-statistic	P-value
A0NT	–.020510	.396799E-02	–5.16875	[.000]
B12	–.046670	.014187	–3.28965	[.001]
A1	.492435	.043280	11.3780	[.000]
A14	.765759E-03	.211678E-03	3.61757	[.000]
B4	.139474	.052096	2.67727	[.007]
C1	.496681	.181677	2.73387	[.006]
A6	–.053257	.021130	–2.52042	[.012]
B8	–.030085	.542547E-02	–5.54520	[.000]
B9	.027602	.650721E-02	4.24176	[.000]
A50	.042432	.023959	1.77106	[.077]
A55	.078379	.026173	2.99465	[.003]
A60	–.155138	.050784	–3.05484	[.002]
A151	1.12805	.223175	5.05454	[.000]
A161	.767818	.208774	3.67775	[.000]
A162	–.310464	.068557	–4.52854	[.000]
A171	.947218	.220886	4.28827	[.000]
A20NT	–.759441E-03	.189466E-03	–4.00832	[.000]
A0YH	–.025648	.491335E-02	–5.22008	[.000]
A20YH	–.954198E-03	.238003E-03	–4.00918	[.000]
A0EM	–.046498	.801417E-02	–5.80197	[.000]
A20EM	–.265426E-04	.279086E-03	–.095106	[.924]
A0WM	–.039027	.744176E-02	–5.24427	[.000]
A20WM	.591911E-03	.296535E-03	1.99609	[.046]
A0SW	–.026963	.525339E-02	–5.13255	[.000]
A20SW	–.873069E-03	.235346E-03	–3.70973	[.000]
A0SC	.317165E-02	.885547E-02	.358157	[.720]
A20SC	–.239276E-02	.510831E-03	–4.68405	[.000]
A0WW	–.042169	.714870E-02	–5.89879	[.000]
A20WW	–.148597E-02	.328872E-03	–4.51837	[.000]
A0ST	–.528847E-02	.405293E-02	–1.30485	[.192]
B8ST	.677468E-02	.856836E-02	.790663	[.429]
B9ST	.319631E-02	.010384	.307817	[.758]
A20ST	.903796E-03	.244486E-03	3.69672	[.000]
A0GL	.091114	.014184	6.42393	[.000]
B8GL	.038618	.016430	2.35040	[.019]
B9GL	–.049746	.019915	–2.49791	[.012]
A20GL	.124861E-02	.616008E-03	2.02694	[.043]

Equation: **North**
Dependent variable: DRLFTE
Mean of dep. var. = -.229675E-02
Std. error of regression = .325066E-02
R-squared = .660470
LM het. test = .130581 [.718]
Durbin-Watson = 2.13691

Equation: **Yorkshire and Humberside**
Dependent variable: DRLFTE
Mean of dep. var. = -.176211E-02
Std. error of regression = .647009E-02
R-squared = .392534
LM het. test = .281892 [.595]
Durbin-Watson = 1.71520

Equation: **East Midlands**
Dependent variable: DRLFTE
Mean of dep. var. = -.175723E-02
Std. error of regression = .656264E-02
R-squared = .555887
LM het. test = .889627 [.346]
Durbin-Watson = 2.15120

Equation: **West Midlands**
Dependent variable: DRLFTE
Mean of dep. var. = -.362542E-02
Std. error of regression = .905062E-02
R-squared = .329601
LM het. test = 2.52679 [.112]
Durbin-Watson = 2.09807

Equation: **South West**
Dependent variable: DRLFTE
Mean of dep. var. = -.123117E-02
Std. error of regression = .711563E-02
R-squared = .517231
LM het. test = .112814 [.737]
Durbin-Watson = 2.51175

Equation: **South**
Dependent variable: DRLFTE
Mean of dep. var. = .143005E-02
Std. error of regression = .250708E-02
R-squared = .636248
LM het. test = .113575 [.736]
Durbin-Watson = 2.78583

Equation: **Greater London**
Dependent variable: DRLFTE
Mean of dep. var. = .543873E-02
Std. error of regression = .586708E-02
R-squared = .480632
LM het. test = .189243 [.664]
Durbin-Watson = 1.85614

Employment

The dependent variable is the change in log ratio of the number of employees divided by working age population for region i minus the equivalent ratio for GB. Data used in estimation for employment, unemployment, working age population and industrial structure are taken from the Oxford Economic Forecasting databases.

(i) All Regions Excluding London and the South

drlempr. = a0.
fixed effect

- a1*rlempr.(-1)
equilibrium correction term.

+ a1*a2*crlempr.(-1)
contiguous region effect. Positive outside GL but negative in GL, see a2gl below, possibly reflecting commuting possibilities.

+b2*drlhp1.h(-1)
relative expected house price appreciation. Retained despite t=1.5 since similar effect is strong in the unemployment equation. Also t ratio is higher in other specifications of this equation.

+ a1*a3* rlhp.(-1)*poogb(-1)
relative house price effect is negative. In reduced form, we cannot be sure whether supply side or demand side factors will win. Negative effect suggests that higher costs associated with high house price regions e.g. costs of land deter location of jobs in those regions, other things being equal. This appears to offset the higher indirect demand for consumption associated with high price regions.

+ a1 * a4 * ((1 – c1) *rlfte.(-2) + c1 * crlfte.(-2))

the negative relative earnings effect. The long-run coefficient is close to minus 1. c1 measures the effect of earnings in contiguous regions relative to GB. C1 is estimated at over 0.5. It is not obvious why the regional spill-over effect should be so large.

+ b6 * apr.(-1)*dlabmr(-1) +b6 * apr.(-1)*dlabmr(-2)

apr is the moving average of the proportion of employment in the production industries relative to GB. Interest rate shocks appear to have a disproportionate effect on regions with high apr.

+b8 * dlrftse(-1) +b9*dlrftseneg(-1)

b8 is negative and b9 positive and almost the same. Dlrftse is the log change in the real FTSE index and dlrftseneg is the same if the index falls and zero if the index rises. Outside GL therefore, the two effects net off when the index falls; but when the index rises, relative employment outside GL suffers. In the GL equation, there is a large effect in the opposite direction suggesting the positive effect on employment in GL when the stock market rises, but no decline when the stock market falls. In the South East, these effects are close to zero.

+a04*pr04.(-1) +a50*(pr5054.(-1))+a55*(pr5559.(-1)) +a55*(pr6064.(-1))

demographic effects on labour force participation. Pr04 is the relative ratio of children aged 0-4 to working age population, pr5054 is the relative proportion of those aged 50-54, and so on. It is well known that participation rates are lower among older workers and women with small children.

+ b153*abr.(-1)*(dlhpgb(-1)-dlpc(-1))

abr is the proportion of employment in banking etc minus the GB value. Interacted with the rate of growth of real national house prices, it suggests that property market upswings are good for employment in regions with large banking sectors.

+ a1*a161 * apr.(-1) + a1*a162 * apr.(-1) *lcomp(-1) + a1*a162 * apr.(-1) *lcomp(-2)

apr refers to the production sector intensity (see above). Lcomp is the log real exchange rate. A high value means that UK industry finds it harder to compete.

+a163* apr.(-1) * wmanufg(-1)

the change in world manuf prod is more significant than world trade.

+ b171 * agr.(-1)

proportion of employment in government sector relative to GB. Negative effect may be related to high relative wage effect of govt. employment found in the earnings equation. Or may indicate policy, locating public sector jobs in low employment regions.

+ a20.*(YEAR-1990);

region specific trend.

(ii) London

drlemprGL = a0GL +a20gl*(YEAR-1990)
- a1*rlemprgl(-1)
+ a1*a2gl*crlemprgl(-1)
+ b2 * drlhp1STh(-1)
+ a1*a3* rlhpgl(-1)*poogb(-1)
+ a1 * a4 * ((1 – c1) *rlftegl(-2) + c1 * crlftegl(-2))
+a5gl *(rlftegl(-1)-rlftest(-1))
+ b6 * aprgl(-1)*dlabmr(-1) +b6 * aprgl(-1)*dlabmr(-2)
+ b8GL * dlrftse(-1) +b9gl*dlrftseneg(-1)
+a04*pr04gl(-1)
+a50gl*(pr5054gl(-1))+a55gl*(pr5559gl(-1))
+a55gl*(pr6064gl(-1))
+ b153*abrgl(-1)*(dlhpgb(-1)-dlpc(-1))
+ a1*a161 * aprgl(-1) + a1*a162 * aprgl(-1) *lcomp(-1) + a1*a162 * aprgl(-1) *lcomp(-2)
+a163* aprgl(-1) * wmanufg(-1)
+ b171 * agrgl(-1) ;

(iii) South

drlemprST = a0ST +a20st*(YEAR-1990)
- a1*rlemprst(-1)
+ a1*a2*crlemprst(-1)
+ b2*drlhp1sth(-1)
+ a1*a3* rlhpst(-1)*poogb(-1)
+ a1 * a4 * ((1 – c1) *rlftest(-2) + c1 * crlftest(-2))
+a5st *(rlftest(-1)-rlftegl(-1))
+ b6 * aprst(-1)*dlabmr(-1) +b6 * aprst(-1)*dlabmr(-2)
+ b8ST * dlrftse(-1) +b9st*dlrftseneg(-1)
+a04*pr04st(-1) ?+a59*pr59st(-1)
+a50*(pr5054st(-1))+a55*(pr5559st(-1))
+a55*(pr6064st(-1))
+ b153*abrst(-1)*(dlhpgb(-1)-dlpc(-1))
+ a1*a161 * aprst(-1)
+ a1* a162 * aprst(-1) *lcomp(-1) + a1*a162 * aprst(-1) *lcomp(-2)
+a163* aprst(-1) * wmanufg(-1)
+ b171 * agrst(-1) ?+ a1*a172 * grst(-2) ;

Parameter	Estimate	Standard Error	t-statistic	P-value
A0ST	.019845	.019610	1.01197	[.312]
A20ST	.254217E-02	.567213E-03	4.48185	[.000]
A1	.457011	.043719	10.4533	[.000]
A2	.254322	.119737	2.12400	[.034]
B2	.030408	.019563	1.55435	[.120]
A3	–.086927	.031640	–2.74741	[.006]
A4	–.893026	.177479	–5.03171	[.000]
C1	.631802	.120179	5.25718	[.000]
A5ST	–.021135	.081786	–.258423	[.796]
B6	–.113801	.032325	–3.52055	[.000]
B8ST	–.011190	.013948	–.802258	[.422]
B9ST	.996528E-02	.016896	.589809	[.555]
A04	–.103968	.044351	–2.34421	[.019]
A50	–.090007	.039158	–2.29859	[.022]
A55	–.069453	.033492	–2.07372	[.038]
B153	.686378	.170456	4.02672	[.000]
A161	1.35978	.265629	5.11909	[.000]
A162	–.334622	.095148	–3.51686	[.000]
A163	.596269E-02	.233500E-02	2.55362	[.011]
B171	–.343172	.180370	–1.90260	[.057]
A0NT	–.065086	.790605E-02	–8.23239	[.000]
B8	–.034379	.817305E-02	–4.20635	[.000]
B9	.035039	.947976E-02	3.69619	[.000]
A20NT	–.980577E-03	.359271E-03	–2.72935	[.006]
A0YH	–.072385	.955868E-02	–7.57266	[.000]
A20YH	–.131808E-03	.306687E-03	–.429779	[.667]
A0EM	–.103961	.014916	–6.96971	[.000]
A20EM	.906744E-04	.368767E-03	.245885	[.806]
A0WM	–.081085	.013220	–6.13334	[.000]
A20WM	.653549E-03	.350220E-03	1.86611	[.062]
A0GL	.316016	.040825	7.74077	[.000]
A20GL	.951403E-02	.148527E-02	6.40558	[.000]
A2GL	–1.36060	.404571	–3.36308	[.001]
A5GL	–.286565	.122546	–2.33842	[.019]
B8GL	.123880	.022292	5.55722	[.000]
B9GL	–.138936	.025829	–5.37902	[.000]
A50GL	.357362	.086338	4.13909	[.000]
A55GL	.209025	.056701	3.68641	[.000]
A0SW	.014801	.701812E-02	2.10902	[.035]
A20SW	.475834E-04	.311731E-03	.152642	[.879]
A0SC	–.027433	.689545E-02	–3.97847	[.000]
A20SC	–.588803E-03	.517752E-03	–1.13723	[.255]
A0WW	–.079147	.011423	–6.92864	[.000]
A20WW	–.110483E-02	.461874E-03	–2.39206	[.017]

Equation: **South**
Dependent variable: DRLEMPR
Mean of dep. var. = .415817E-02
Std. error of regression = .567101E-02
R-squared = .360849
LM het. test = .473981 [.491]
Durbin-Watson = 2.27003

Equation: **North**
Dependent variable: DRLEMPR
Mean of dep. var. = -.104014E-02
Std. dev. of dep. var. = .992561E-02
R-squared = .306293
LM het. test = .015590 [.901]
Durbin-Watson = 1.10925

Equation: **Yorkshire and Humberside**
Dependent variable: DRLEMPR
Mean of dep. var. = -.337120E-03
Std. error of regression = .568476E-02
R-squared = .584859
LM het. test = .292387 [.589]
Durbin-Watson = 2.47922

Equation: **East Midlands**
Dependent variable: DRLEMPR
Mean of dep. var. = -.154451E-02
Std. error of regression = .926656E-02
R-squared = .159363
LM het. test = 1.15149 [.283]
Durbin-Watson = 1.45334

Equation: **West Midlands**
Dependent variable: DRLEMPR
Mean of dep. var. = -.150721E-02
Std. error of regression = .818593E-02
R-squared = .348877
LM het. test = .858382 [.354]
Durbin-Watson = 1.99993

Equation: **Greater London**
Dependent variable: DRLEMPR
Mean of dep. var. = -.356105E-02
Std. error of regression = .684178E-02
R-squared = .782701
LM het. test = .862323 [.353]
Durbin-Watson = 2.23176

Equation: **South West**
Dependent variable: DRLEMPR
Mean of dep. var. = .113910E-02
Std. error of regression = .010772
R-squared = .390758
LM het. test = 1.92431 [.165]
Durbin-Watson = 1.92193

Unemployment

The unemployment rate differentials are scaled by the lagged GB unemployment rate. The key effects are real relative wages (positive), the real exchange rate scaled by the proportion of employment in the production sector (positive), real house price appreciation scaled by the proportion of employment in the banking sector (negative), and expected relative appreciation of house prices (negative). These are fairly robust across different specifications. The dependent variable is the change in the unemployment rate in region (i) minus the unemployment rate in GB, all scaled by the unemployment rate in GB lagged one year. The equations are set out below. Note, however, that estimated equations now exist for employment, unemployment and the population of working age. Arguably, we only need two out of the three (if the percentages of the population who are long-term sick, carrying out home duties etc. are approximately constant) and Version 2 of the model uses a much simpler pseudo-identity to determine unemployment. This appears in row 17.

(i) All Regions Excluding London and the South

100*drur./urgb(-1) = a0.
fixed effect.

+ b11 *100* drur.(-1)/urgb(-1)
some persistence of differential shocks. Since b11 is close to a1, it may also suggest the ecm is at a lag of 2 years.

+ b12 * 100*cdrur.(-1)/urgb(-1)
contiguous region change in scaled lagged unemployment rate. Small negative coefficient may reflect migration.

– a1 * 100*rur.(-1)/urgb(-1)
equilibrium correction term. See comment on b11 above.

+ a1 * a2 * 100*crur.(-1)/urgb(-1)
contiguous region effect of unemployment differentials. Negative but not large or very significant. Consistent with discussion of b12 effect above. However, effect is different in London.

+ b2 * drlhp1.h(-1)
naïve forecast of relative house price appreciation in region relative to GB. Has negative effect which is consistent both with demand side (capital appreciation raising local demand) and supply side (low relative user cost encourages investment and migration of managerial and professionals, which reduces unemployment of the less skilled)

+ a1 * a3 * rlhp.(-1)
relative log house price effect.

+ a1 * a4 * ((1 – c1) *rlfte.(-2) + c1 * crlfte.(-2))
relative earnings effect on unemployment differential.
Lag of 2 is chosen by testing shorter lag. Consistent with ecm at lag of 2 as discussed above. Strongly positive value of a4 is consistent with labour demand interpretation, but could also reflect higher labour supply in high wage regions. C1 positive could reflect contiguous region labour supply effect – high labour supply in contiguous region raises unemployment in this region. However, setting c1 to zero has little impact on the other parameters.

+ b6 * apr.(-1) * dlabmr(-1)
apr is the 2-year moving average of the proportion of employment in the production sector.
A positive value of b6 indicates that an interest rate shock raises relative unemployment in regions where the production sector is important.

+ b9 * dlrftseneg(-1)

dlrftseneg is the value of the real log change in the FTSE index when this is negative. B6 positive outside the South East and Greater London and correspondingly negative in those regions, indicates that those regions suffer rising relative unemployment in stock market downturns. This is not surprising given the importance of financial services in these regions.

+ a55 * pr5559.(-1) + a55 * pr6064.(-1)

the relative proportion of the working age population in the 55 to 64 age group has a negative effect on the relative unemployment rate. This may reflect the partial withdrawal of that age group from the labour force, so lowering their representation in the unemployment count. The effect is especially negative in Greater London (see a55gl coefficient below), possibly also indicating higher skill and responsibility levels in the London work force among older workers.

+ b153 * abr.(-1) * (dlhpgb(-1) – dlpc(-1))

abr is the 2-year moving average of relative employment in the banking and financial services industry. When real GB house prices appreciate this reduces unemployment in regions where this sector is relatively important.

+ a1 * a161 * apr.(-1)

apr is the 2-year moving average of the proportion of employment in the production sector. The term lcomp in the next expression is not mean adjusted so this term is needed.

+ a1 * a162 * apr.(-1) *lcomp(-1)

lcomp is the log real effective exchange rate. A high value means an overvalued currency. This is bad for the tradeable sector and so raises unemployment in regions where production industries are important. A similar effect is found in the employment rate equations.

+ a20. * (year – 1990)

region specific trend.

+ a21. * tr90

region specific split trend zero up to 1989, 1 in 1990, 2 in 1991 etc. Call centres began to expand strongly around that time with lower IT and telephony costs and this may have altered unemployment differentials.

(ii) London

100* drurGL/urgb(-1)_ = a0gl+ a20gl * (year – 1990)
+ a21gl * tr90 + b11 * 100*drurgl(-1)/urgb(-1)
+ b12 * 100*cdrurgl(-1)/urgb(-1) – a1 * 100*rurgl(-1)/urgb(-1)
+ a1 * a2gl *100* crurgl(-1)/urgb(-1)
+ b2 * drlhp1STh(-1) + a1 * a4 * ((1 – c1) *rlftegl(-2) + c1 * crlftegl(-2))
+ b6 * aprgl(-1) * dlabmr(-1)+ b9gl * dlrftseneg(-1)
+ a55gl * pr5559gl(-1)+ a55gl * pr6064gl(-1)
+ b153 * abrgl(-1) * (dlhpgb(-1) – dlpc(-1))
+ a1 * a161 * aprgl(-1) + a1 * a162 * aprgl(-1) *lcomp(-1)

(iii) South

100*drurst/urgb(-1) = a0ST+ a20st * (YEAR – 1990)
+ a21st * tr90 + b11 * 100*drurst(-1)/urgb(-1)
+ b12 * 100*cdrurst(-1)/urgb(-1) – a1 * 100*rurst(-1)/urgb(-1)
+ a1 * a2st *100* crurst(-1)/urgb(-1) + b2 * drlhp1sth(-1)
+ a1 * a4 * ((1 – c1) * rlftest(-2) + c1 * crlftest(-2))
+ b6 * aprst(-1) * dlabmr(-1) + b9st * dlrftseneg(-1)
+ a55 * pr5559st(-1)+ a55 * pr6064st(-1)
+ b153 * abrst(-1) * (dlhpgb(-1)-dlpc(-1)) + a1 * a161 * aprst(-1)
+ a1 * a162 * aprst(-1) * lcomp(-1)

Parameter	Estimate	Standard Error	t-statistic	P-value
A0ST	–13.6571	2.75746	–4.95279	[.000]
A20ST	.020930	.145939	.143412	[.886]
A21ST	–.016434	.227031	–.072387	[.942]
B11	.340321	.050331	6.76167	[.000]
B12	–.097863	.022439	–4.36125	[.000]
A1	.282210	.026613	10.6043	[.000]
A2ST	.040592	.117345	.345922	[.729]
B2	–18.7565	5.41912	–3.46117	[.001]
A4	524.986	150.004	3.49980	[.000]
C1	.381090	.158678	2.40165	[.016]
B6	53.0414	25.5279	2.07778	[.038]
B9ST	14.0342	2.63172	5.33271	[.000]
A55	–28.2610	13.4396	–2.10281	[.035]
B153	–154.182	56.5153	–2.72815	[.006]
A161	82.7304	209.027	.395787	[.692]
A162	417.073	147.147	2.83440	[.005]
A0NT	17.9913	2.91491	6.17215	[.000]
A2	–.159393	.084988	–1.87548	[.061]
B9	–7.61602	1.22302	–6.22720	[.000]
A20NT	–.190344	.173594	–1.09649	[.273]
A21NT	.216308	.219663	.984729	[.325]
A0YH	15.2596	3.20995	4.75385	[.000]
A20YH	.654081	.183368	3.56705	[.000]
A21YH	–.381600	.224904	–1.69672	[.090]
A0EM	8.06538	6.03623	1.33616	[.181]
A20EM	.838907	.180760	4.64099	[.000]
A21EM	–.587355	.284036	–2.06789	[.039]
A0WM	13.0621	5.41905	2.41041	[.016]
A20WM	.645154	.289565	2.22801	[.026]
A21WM	–.696188	.452042	–1.54010	[.124]
A0GL	–30.7282	7.98630	–3.84762	[.000]
A20GL	–1.08265	.357850	–3.02545	[.002]
A21GL	–.203735	.246573	–.826264	[.409]
A2GL	.812233	.367625	2.20941	[.027]
B9GL	19.4656	3.44591	5.64889	[.000]
A55GL	–73.7662	16.6297	–4.43580	[.000]
A0SW	5.03545	2.40461	2.09408	[.036]
A20SW	–.309475	.197103	–1.57012	[.116]
A21SW	.431189	.328144	1.31402	[.189]
A0SC	11.3872	3.05082	3.73249	[.000]
A20SC	–.490249	.238697	–2.05386	[.040]
A21SC	1.07293	.392566	2.73312	[.006]
A0WW	19.0284	3.55986	5.34525	[.000]
A20WW	–.161277	.235827	–.683879	[.494]
A21WW	.491348	.347090	1.41562	[.157]

Equation: **South**
Dependent variable: DRUR

Mean of dep. var. = -.349733
Std. error of regression = 2.35141
R-squared = .789635
LM het. test = 4.06751 [.044]
Durbin-Watson = 2.29001

Equation: **North**
Dependent variable: DRUR

Mean of dep. var. = -.057688
Std. error of regression = 2.53154
R-squared = .799717
LM het. test = 1.24065 [.265]
Durbin-Watson = 1.55343

Equation: **Yorkshire and Humberside**
Dependent variable: DRUR
Mean of dep. var. = -.390013
Std. error of regression = 2.43588
R-squared = .694526
LM het. test = .250106E-02 [.960]
Durbin-Watson = 2.91316

Equation: **East Midlands**
Dependent variable: DRUR
Mean of dep. var. = .073414
Std. error of regression = 2.91886
R-squared = .219006
LM het. test = .373602 [.541]
Durbin-Watson = 1.77952

Equation: **West Midlands**
Dependent variable: DRUR
Mean of dep. var. = 1.89661
Std. error of regression = 5.54228
R-squared = .591882
LM het. test = 2.30104 [.129]
Durbin-Watson = 1.59077

Equation: **Greater London**
Dependent variable: DRUR
Mean of dep. var. = .038279
Std. error of regression = 2.28392
R-squared = .864162
LM het. test = 7.28747 [.007]
Durbin-Watson = 2.50269

Equation: **South West**
Dependent variable: DRUR
Mean of dep. var. = .022162
Std. error of regression = 3.68259
R-squared = .762776
LM het. test = 1.52419 [.217]
Durbin-Watson = .904999

References

Andrew, M and G Meen (2003) *"Housing Transactions and the Changing Decisions of Young Households in Britain: The Microeconomic Evidence"*. Real Estate Economics, 31(1): 117-138.

Cameron, G and J. Muellbauer. (1998). *"The Housing Market and Regional Commuting and Migration Choices"*. Scottish Journal of Political Economy, 54: 420-446.

Fernandez-Corugedo, E and J. Muellbauer. (2004). *"Consumer Credit Conditions in the UK"*, forthcoming, *Bank of England Working Paper*.

Meen, G.P. (1999), *"Regional House Prices and the Ripple Effect: A New Interpretation",* Housing Studies, 14(6): 733-753.

Meen, G.P., and M. Andrew. (1998). *"On the Aggregate Housing Market Implications of Labour Market Change."* Scottish Journal of Political Economy 45(4): 393-419.